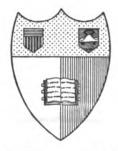
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THE PATHOLOGICAL LABORATORY

LONDON COUNTY ASYLUMS
CLAYBURY ESSEX

VOL. II



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ARCHIVES OF NEUROLOGY

FROM

THE PATHOLOGICAL LABORATORY

OF THE

LONDON COUNTY ASYLUMS

CLAYBURY, ESSEX

EDITED BY

FREDERICK WALKER MOTT, F.R.S., M.D., F.R.C.P.

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VOL. II.

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, CONTENTS.	
· · · · · · · · · · · · · · · · · · ·	
	PAGE
Tabes in Asylum and Hospital Practice. By F. W. Mott, M.D., F.R.S.	1
Introduction	1
Current Views of Relation of Tabes to General Paralysis in Standard	
Text-books	4 10
Etiology of Tabes and Tabo Paralysis	10
after Redlich	11
Statistics of Syphilis in Sixty-two Cases of Tabes Dorsalis	12
Statistics of Syphilis in Sixty-two Asylum Cases of Tabo-Paralysis	13
Birth and Death-rate of Tabic and Tabo-Paralytic Patients	14
Statistics Relating to General Paralysis in Women	15
Conjugal Tabes and Paralysis	17
Post-mortem Table Results in Reference to Syphilitic Residua in	
Tabes, compared with the Post-mortem Results in Tabe-Paralysis	
and General Paralysis	22
Racial Syphilis in Uncivilised Countries in Relation to Tabes and	
General Paralysis	23
Stress, Physical and Mental, Exposure, Injury, Hereditary Pre	; -
disposition and Intemperance	25
Mode of Onset of Tabes and Tabo-Paralysis	27
Decades at which the Onset of Symptoms occurred	27
Symptomatology	30
Eye Symptoms of Tabes and Tabo-Paralysis	30
Inequality, Irregularity and Size of Pupils	31
Section II.—Sensory Disturbances	36
Method of Examination	37
Subjective Sensory Phenomena of Tabes and Tabo-Paralysis	42
Paræsthesia	45
Objective Sensory Disturbances	45
Visceral Disturbances	53
Affections of Cranial Nerves	62
Diseases of the Bones and Joints	64
Motor Disturbances	70
Cerebral Symptoms	71
Cases	88
Morbid Anatomy and Pathology	259
Notes upon the Pathology of Tabes and Tabo-Paralysis	
Amentia. (Idiocy and Imbecility.) By A. F. Tredgold, L.R.C.P.Lond.,	
M.R.C.S.Eng	328
Bolton, B.Sc., M.D., B.S.Lond., M.R.C.P	744
By George A. Watson, M.B. C.M. Edin	621

Contents

	PAGE
The Coagulation-Temperature of Cell-Globulin, and its Bearing on	
Hyperpyrexia. By W. D. Halliburton, M.B., F.R.S., and F. W. Mott,	
M.D., F.R.S	727
The Prevention of Dysentery in the London County Asylums. By	
F. W. Mott, M.D., F.R.S	735
The Range of Immediate Association and Memory in Normal and Patho-	
logical Individuals. By W. G. Smith, M.A. Edin., Ph.D. Leipzig	767
Pathological Changes in the Medulla Oblongata in Acute Diphtheritic	
Toxemia. By Charles Bolton, B.Sc., M.D., M.R.C.P	806
Systematic Examination of the Central and Peripheral Nervous System	
and Muscles in a Case of Acute Alcoholic Paralysis with Mental	
Symptoms. By Sydney J. Cole, M.A., M.D., B.Ch.Oxon	835
Note upon the Choline Test for Active Degeneration of the Nervous	
System. By F. W. Mott, M.D., F.R.S	858

LIST OF ILLUSTRATIONS.

PAGE
Tabes in Asylum and Hospital Practice. Plates I., II., III., IV., V.,
VI., VII., VIII. Figs. 1-48 47, 50, 51, 67, 69, 81, 102, 104, 105, 107,
108, 109, 111, 112, 113, 114, 115, 125, 126, 130, 134, 135, 136, 138, 140, 146,
147, 157, 158, 160, 162, 174, 175, 179, 180, 192, 206, 239, 265, 268, 271, 274,
277, 278, 282, 285, 306, 310, 313
Amentia (Idiocy and Imbecility). Plates I., II., III. Fig. 1 420, 421, 422,
428
The Histological Basis of Amentia and Dementia. Plates I., II., III.,
IV., V., VI. Figs. 1-24 557, 567, 568, 569, 571, 572, 573, 574, 575,
581, 584, 586, 587, 589, 594, 595, 596, 601, 602, 606, 607, 609, 613, 614, 617,
618, 619, 620, 620a, 620b
The Pathology and Morbid Histology of Juvenile General Paralysis.
Plates I., II
The Prevention of Dysentery in the London County Asylums. Plates I.,
II., III. Charts I., II., III., IV., V. Plans I., II. 741, 742, 743, 744,
745, 752, 755, 766
Pathological Changes in the Medulla Oblongata in Acute-Diphtheritic
Toxemia. Plate I. Fig. 1 812, 834
Systematic Examination of the Central and Peripheral Nervous System
and Muscles in a Case of Acute Alcoholic Paralysis with Mental

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EDITORIAL PREFACE.

THE preface to the first volume of the Archives of the Laboratory of the London County Asylums was kindly written by Sir William J. Collins, M.D., then Chairman of the County Council, and promoter of the foundation of the Laboratory. In it he pointed out "that various momenta have contributed to the recognition of the need of more determined, systematic and exhaustive research into the causes of insanity," but it has since been found that it is also within the scope of the pathologist to advance the better treatment of the insane by preventing the acquirement of communicable diseases during their residence in an institution. In fact, an enquiry which I undertook with the aid of Dr. Durham into the prevention of dysentery in the London County Asylums and the issue of a Report thereon has been in great measure the cause of delay in the publication of this volume. It is satisfactory, however, to find that the recognition of this disease as infective, and the adoption of a number of recommendations which we made, have been the means of diminishing the death rate, at any rate, at Claybury, where it was prevalent in an endemic or epidemic form for years; and it is not too much to hope that if all our suggestions, and the additional precautions noted in the article entitled "The Prevention of Dysentery in Asylums," be carried out, that the disease will occur only in sporadic cases, and seldom become endemic, or attain an epidemic form. It is interesting to find that the Commissioners in Lunacy, in their last Report, June 27, 1902, have adopted the term Dysentery instead of Colitis, and initiated "a plan based on that adopted by Dr. Mott to ensure the registration and notification of cases of dysentery and diarrhœa in asylums amongst members of the staff as well as patients," and that they now recognise the fact that it is a communicable disease.

The recently adopted system of notification of tuberculosis which I have instituted should prove of great value in showing the prevalence of this disease among inmates of the different asylums, old and new; on clay soil, on gravel, and on chalk; in different forms of insanity; the relation of the disease to length of residence and acquirement in the asylum, or its presence on admission. The opportunities afforded of making autopsies, and thus verifying the clinical results, will help to settle the question, whether a larger proportion relatively of the inmates of the London County Asylums die from tuberculosis than those outside of corresponding adult ages.

It is undeniable that a further and more accurate knowledge of the important subject of tuberculosis in relation to insanity and its treatment in large institutions is very essential, and it is hoped that this new system of notification which the Asylums Committee have adopted may become general in England. The difficulties of diagnosis of tuberculosis in the insane are very great, as they do not expectorate, and often they resist physical examination either by not breathing, or by shouting and struggling; but the pathologist can obtain accurate statistics of the prevalence of the disease by careful and systematic post-mortem examination. Thus, in a year or two, reliable evidence will be forthcoming to decide many of these points, and to help the authorities in determining the best course to adopt for its prevention.

Another work which I have undertaken, and the importance of which is now widely recognised, is an investigation into the relation of syphilis to insanity. In the first volume of the Archives I showed that there was good ground for believing that the most important and possibly the essential cause of general paralysis, a disease which affects a large class often of the best and ablest minds of our town population, is syphilis, which is a communicable, therefore a preventible disease. In the present volume I show that etiologically general paralysis is identical with tabes dorsalis, therefore a large part of these and other organic nervous diseases affecting the community are due to syphilis.

The same experience applies to ophthalmic practice.

Blindness, paralysis, physical and mental incapacity, are too often, therefore, the result of a preventible disease. At the last annual meeting of the British Medical Association at Manchester, I opened an address in the Medico-Psychological Section on the relation of syphilis to insanity. subject was fully discussed with the result that a resolution was unanimously carried urging the authorities to take some steps to prevent the spread of syphilis. Too much reliance need not be placed upon unanimous expressions of opinion at meetings of this kind, for there are always a large number of people who, having no ideas of their own, are ready to follow the one which is at present uppermost; but on this occasion there were present a number of alienists holding some of the most responsible positions in the country, and who have had unexampled opportunities of examining the question and of forming an opinion based upon practical knowledge and experience. I feel convinced that such an unanimous expression of opinion with regard to the relationship of syphilis to general paralysis could not have been obtained a few years ago; for many of those present have, after mature consideration, and I presume, investigation, changed their opinions, in support of the views which I uphold. The communications in this volume by myself, Dr. Watson and Dr. Bolton all emphasise this important relationship. Dr. Tredgold's very interesting paper, which deals with 150 cases of idiocy and imbecility, shows that heredity is the most important cause of these conditions; likewise, Dr. Bolton's and Dr. Watson's cases illustrate the important share heredity plays in mental diseases.

My own cases, which deal only with one class of insanity, do not show the same preponderance of hereditary taint, and I am convinced that in dementia paralytica heredity is not such an important factor as in other forms of insanity.

Dr. Tredgold also points out the importance of alcoholism and tuberculosis as etiological factors in the production of idiocy and imbecility. Syphilis, according to his observation, plays a less important rôle, but it is interesting to note that where congenital syphilis existed the juvenile form of general paralysis affected these imbeciles during adolescence.

Of the influence of alcohol in the production of insanity and in the acceleration of all devitalising processes, there can be no question. The paper by Dr. Cole is upon a type of alcoholic paralysis and dementia which is frequently met with in asylums and hospitals. That by Dr. Chas. Bolton shows the influence of a specific poison in the production of an elective neuronic degeneration—such as the diphtheritic toxin and its effect upon the heart. Had space permitted, I should have published a number of other cases of alcoholic paralysis that I have investigated, but they must be held over for a future number of Archives by which time I hope that I may have had the opportunity of examining the brains and nervous systems of some acute cases of alcoholic poisoning uncomplicated by other toxic conditions, such as pneumonia.

Since necessarily a year at least will elapse before the materials are complete for a third volume of "Archives of the Laboratory." I have been obliged to put two of the papers which have been awaiting publication into Brain, the Journal of the Neurological Society. Also much of my own completed research work has been held over, owing to lack of space.

Anyone who will peruse the brief clinical notes of the large number of cases (selected from a much larger number), published in this volume, will find in the family histories a third cause of insanity, namely, mental worry and anxiety in its many forms; and he would learn that it is seldom one factor alone that may be considered the cause of the patient's affliction; more often two or more conspire together. Stress, heredity, and often a poison in the blood are the factors I indicate; and the problem of the prevention of insanity resolves itself into the prevention of syphilis, tuberculosis, and other communicable diseases—restriction of the abuse of alcohol, the removal of worry and mental anxiety—and the control of unsuitable marriages; or at most the education of the public to the dangers of the intermarriage of neuropathic individuals, or the marriage of an individual with an hereditary history of epilepsy or insanity with another of the neurotic temperament, in whom there is sometimes potential insanity.

It might be asked, how can we remedy mental stress and worry among the deserving poor? I am of opinion that oldage pensions, or some such scheme for workpeople as exists in Germany and commencing to be put into practice in Sheffield and Birmingham, would do much to keep out a number of people from the asylums. Also the better housing of the poor and the reduction of rents, with cheap locomotion would, I am convinced, by removing the present terrible overcrowding, reduce a most fruitful cause of tuberculosis, venereal disease, alcoholism, drunkenness, filth, and vice.

There is yet one point which it is desirable to mention as a result of both hospital and asylum experience, and that is the necessity of some earnest attempt being made to establish a means of intercepting for hospital treatment such cases of incipient and acute insanity as are not yet certifiable, It is probable that many would never come into the asylums, and a certain number of cases would thus come under observation willingly, and in time to retard the progress of the disease. Practitioners could send doubtful cases for observation and treatment to such hospitals, where, moreover, the opportunity would be afforded of improving their own knowledge as to the early signs of insanity. The importance of this idea, which I advocated in a report to the Council shortly after my appointment, is shown by the fact that it has been strongly taken up in Scotland by Sir John Sibbald and Prof. Clouston, who desire to see special wards established in connection with general hospitals. case coming out of such a ward would not thereby be stigmatised as insane.

Few, if any, of the hospitals in London have at present provision for these incipient and doubtful cases.

If acute hospitals or receiving houses were established by the Asylums Committee, a number of cases which at present are taken to the asylums would never go there, and a better classification and a better knowledge of the physical and mental states of the patients transferred would ensue.

The laborious researches of Dr. Joseph Bolton upon "The Degeneration of Certain Layers of Cells of the Cerebral

Cortex," are of great interest as regards the functions of the They show that these particular cells which exist throughout the gray matter covering the cerebrum are developed later than the other cellular structures; that as the development of the mind takes place they increase in size and complexity, and consequently the strip of brain structure which they form increases in thickness; should, however, the brain possess an inherent defect of development such as occurs in idiocy and imbecility, these layers of cells, which are infinite in number, do not properly develop, and never attain the complexity of structure characteristic of the normal brain. Correspondingly, Dr. Bolton has shown that in proportion to the degeneration of these structures is the superficial destruction of the brain surface and the dementia, and this applies to all forms of insanity. There is therefore in this work a fundamental principle in the correlation of mind and matter.

The careful histological examinations of the central nervous systems of eleven cases of juvenile general paralysis by Dr. Watson is a valuable contribution and addition to the article which I wrote on the subject in the first volume of the Archives, for a number of the cases reported there have since been thus systematically investigated.

It is pleasant to me here to remark that Dr. Watson now holds the British Medical Association Scholarship; and it is to be regretted that the Board of Technical Education could not continue the Scholarship to Dr. Tredgold, whose scientific work gave such promise, and who has consequently withdrawn into general practice. Perhaps some other public body or private individual may be induced to come forward with the offer of a similar scholarship.

A number of gentlemen have availed themselves of the opportunity of working in the Claybury Laboratory, and again, as Director, I wish to make known the fact that the Pathological Committee have always granted permission to applicants to make use of the splendid opportunities for obtaining material which this laboratory affords. Some medical men, however, have found the distance and difficulty of approach so great, as to debar them from the privilege.

Several have lived in the neighbourhood: for example, Dr. Gordon Wilson, of Chicago, Dr. Graham, and Dr. Smith, who has devoted a large part of his time to the experimental study of memory in the insane. His valuable contribution, which involved an immense amount of laborious observation and enquiry, is contained in this volume.

It is a satisfaction to know that Dr. Smith's work in experimental psychology has been recognised by his appointment as lecturer at King's College, London.

With the permission of the Committee, I applied for recognition of the Laboratory by the London University. Unfortunately the Senate were unable to comply with this request, since the Laboratory is not situated in the area circumscribed by the new university. This appears to me a great pity, and the more so as the Board of Studies of Advanced Medicine, on which I have the honour to be one of the representatives of Pathology, has recommended that candidates for the M.D.London, can take pathology or mental diseases as a special subject. To those whose minds are bent upon neuro-pathology, what better opportunities could be obtained than by working in this London County Asylum Laboratory with the vast amount of material which could be placed at their disposal? A number of the officers at the London County Asylums other than Claybury would take advantage of the Laboratory and its resources were it more central, and although it is of great advantage to have association of the Laboratory and the wards, still, a large proportion of cases will be observed to have been obtained from the other asylums. As I have the right of visiting all the asylums and of seeing the clinical aspects of the cases during life, I see no objection to having the Laboratory placed in London, where its field of usefulness would be greatly extended, and it might thus be made a centre of neuro-pathological science.

Two gentlemen have already distinguished themselves by theses composed from work done in our Laboratory, and Dr. Pugh, who at my suggestion undertook a research upon "The Alkalinity of the Blood in Epilepsy," was fortunate enough to obtain a gold medal at the University of Edinburgh. This will appear in the next number of *Brain*. Dr. Cole's thesis was successful in obtaining for him the M.D.Oxford, which University, however, confers no special distinction in addition to the degree.

It has been of inestimable advantage to me to have had the co-operation of so distinguished a physiologist as Professor Halliburton, F.R.S., who has been my collaborator in one of the papers in this volume and in several papers on the "Chemistry of Nerve Degeneration" in the *Philosophical Transactions of the Royal Society*. Since he is Director of the Laboratory at King's College which, unlike mine, is licensed for vivisection, he has performed all experiments incidental to the researches we have in recent years carried out. I find it necessary to publicly state this, and to repeat the fact that no experiments on living animals have ever been made or contemplated at the Pathological Laboratory of the L.C.A.

The utility of pathological work cannot be gauged solely by the immediate results obtained, but every additional fact towards the elucidation of the complex structure or biochemical conditions of the nervous system in health and disease may be the starting point of some valuable discovery, and a new technique or method of observation may not only lead to work by its discoverer, but by a crowd of other workers who see in it future developments from other points of view.

In conclusion, I will take the opportunity of thanking my former assistant, Dr. Hamilton Wright, for the histological notes of several of the cases of tabo-paralysis, also to acknowledge my indebtedness to Messrs. John Murray and Co. for kindly allowing me the use of two blocks (figs. 25 and 29), prepared from photographs which I supplied to Dr. Poore for his work on "Forensic Medicine."

FREDERICK WALKER MOTT.

25, Nottingham Place, W., December, 1902.

ARCHIVES OF NEUROLOGY OF THE PATHOLOGICAL LABORATORY

OF THE

LONDON COUNTY ASYLUMS

TABES IN ASYLUM AND HOSPITAL PRACTICE.

BY F. W. MOTT, M.D., F.R.S.

Introduction.

As I have pointed out in an article on "Brain Syphilis," an artificial classification of diseases obtains owing to our system of administration of relief to the suffering poor, by which asylum doctors see particularly those cases with mental symptoms, while hospital physicians meet with those cases especially which manifest physical signs of paralysis, sensory disturbances, &c. Thus it is with tabes and general paralysis. But in the almost unique position in England which I hold, of being able to study diseases both in hospital and asylum practice, and with the vast field which the latter offers to me as Pathologist to the London County Asylums, I am enabled to study all types of this disease from cases presenting purely spinal symptoms, to cases presenting mental symptoms which would lead to a diagnosis of general paralysis.

In order to increase my field of observation, and also with the knowledge that some of the cases might eventually come under further observation at one or other of

the various asylums, I have visited a number of the infirmaries in order to study cases of tabes dorsalis in the paralytic stage or with premonitory mental symptoms. Some of these cases have since come into the asylums and died; others, I have found, had relatives, consanguineous or conjugal, dying in the asylums. I have been enabled to obtain thirty post-mortem examinations, and a systematic macroscopic and (in the great majority of instances) microscopic examination of the brain and spinal cord has been made of each; frequently, also, the spinal ganglia, peripheral nerves, optic nerves, retinæ, and other structures, have been examined.

In some of these cases a full and detailed report will be given; but where it is only wearisome repetition, this will not be done; but the facts will, I trust, be accepted as true, being deductions from my personal observations on many thousands of sections of the central and peripheral nervous systems. Likewise with the clinical notes of the cases, which include more than sixty cases of tabes dorsalis and sixty cases of the tabetic form of general paralysis, I shall only record in full those cases which present some very interesting facts or rare condition.

I have examined systematically the sensory disturbances in fifty cases of tabes dorsalis, and in a number of such cases of tabetic general paralysis which were capable of giving reliable answers; also other clinical signs and symptoms, including the mental condition. The amount of work involved in this can only be appreciated by those who have had a similar experience, and, of course, this research is not yet ended, for the majority of the cases I have observed clinically have not yet come to the post-morten table. I found it advisable, owing to the vast amount of material at my disposal, to limit my observations to one class of disease, and in selecting this, tabes dorsalis, I thought it was possible to associate some of the mental disturbances with the changes which one meets in the nervous system, and to show that the illusions, delusions, and hallucinations have an organic basis, and that there is a great analogy between the paroxysms of pain, the visceral crises of tabes,

and the epileptiform fits, attacks of mania, delirium, hallucinations, and other mental disturbances which occur in general paralysis.

In the study of these cases, just as one can trace all grades of organic lesions from the purely spinal, through spinal with slight cerebral change, to extreme cerebral change and slight spinal change, so one can trace corresponding clinical symptoms. Many cases begin with marked spinal change and accompanying spinal symptoms; there is then a sudden or gradual outburst of mental symptoms and the spinal sink into the background. So much may the cerebral symptoms overshadow, obscure, and even obliterate the spinal symptoms, that they may be overlooked and disregarded. In fact, I have seen so many cases in which ataxy has disappeared with the progressive cerebral disease that I am reminded of the truth of the dictum of Hughlings Jackson that "one half of the symptoms of nervous diseases are due to the unbalanced action of healthy structures." That many of these cases were in the second stage of tabes, and yet evinced after the onset of the mental symptoms little or no ataxy in their movements, was shown by the examination of their spinal cords and posterior roots. At a discussion opened by myself at the Pathological Society upon the unity of tabes and general paralysis, most of the leading authorities—Sir William Gowers, Dr. Buzzard, Dr. Savage, Dr. Ferrier, Dr. Hale White, Dr. Head, and others, who spoke—were of the opinion that etiologically and pathogenetically the two diseases were identical. This view has not, however, found its way into the text-books, although, as a matter of expediency, it is often adopted by physicians, for when a noble or distinguished patient suffers from grandiose delusions and other signs of the progressive brain disease which in a few years will terminate fatally, it is given out that he is suffering from locomotor ataxy. I maintain that etiologically and pathogenetically there is one tabes which may begin in the brain (especially in certain regions), or in the spinal cord in certain regions, or in the peripheral nervous structures connected with vision, or in nervous structures connected with the viscera, constituting, therefore, different types, any of which may be present or be associated with one or all of the others. More and more we are coming to the opinion that syphilis is the cause of the degenerative process evinced, and although many authorities will not go so far as Möbius, who considers that all cases are metasyphilitic, or Fournier, who calls them para-syphilitic, still the majority of neurologists and alienists in England and Germany believe that syphilis is the main causal factor of this polymorphic disease. The experimental observations of Krafft-Ebing, and the fact that practically all cases of hereditary tabes and almost all cases of juvenile general paralysis can be proved to have occurred in the children of syphilitic parents strongly supports the syphilitic doctrine of this disease.

CURRENT VIEWS OF RELATION OF TABES TO GENERAL PARALYSIS IN STANDARD TEXT-BOOKS.

Since Westphal showed the existence of posterior-column-sclerosis in cases of general paralysis, nearly all neurologists have gradually come to recognise a close alliance between tabes dorsalis and general paralysis. It would be impossible to relate all the literature that has been written on this subject, but I will give a few quotations from some leading alienists and neurologists. The first in this country to recognise the association was Dr. Savage, and he says (Article on Locomotor Ataxy, "Tuke's Dictionary of Psychological Medicine"):

"Locomotor ataxy and insanity may occur in the same person and be unconnected, or locomotor ataxy may precede the development of associated mental symptoms, or locomotor ataxy symptoms may be the first indication of general paralysis of the insane. Locomotor ataxy and general paralysis may to some extent alternate, so that while the ataxic symptoms are fully developed the mind is clear; and while the mind is disordered the ataxy becomes less or is absent. Locomotor ataxy may have the following special reactions mentally: there may be during the course of the disease mental crises; a patient who is recognised as suffering from locomotor ataxy suddenly becomes manaical.

In these cases generally there is more or less suspicion, or a tendency to retaliate on those who are supposed to be causing the painful sensations in various parts of the body. These maniacal attacks are of short duration, but may recur at regular intervals. There may be insane interpretations of the ordinary crises, so that one patient says that his bowels have been twisted by his persecutors, and another says that red-hot irons have been thrust in his feet and eyes, and another complains that unnatural means have been used to withdraw his semen. The ordinary symptoms of locomotor ataxy are insanely explained in other ways. The mental symptoms of these cases may be acute or chronic; in the former case they may alternate, so while the delusions exist the ataxy is better, and vice versa; or the insanity may be transient or recurrent. In some cases the insanity may be as chronic as the locomotor ataxy, but there seems to be little tendency to dementia in these patients. The most common relationship of insanity and locomotor ataxy is met with in general paralysis of the insane, and in this the symptoms of both may begin at the same time, so that with extravagance, boastfulness, and lust ataxic weakness may develop. In other cases locomotor ataxy is the first symptom, and after a period varying from one to seven years, other symptoms point to the existence of general paralysis. In some cases the general paralysis has first been recognised, and it is only later that locomotor ataxy is recognised."

Mickle (Article on General Paralysis: "Tuke's Dictionary of Psychological Medicine") merely states that "the ascending form of general paralysis must be distinguished from tabes dorsalis, at times a difficult task," otherwise hardly any notice is taken of this form of general paralysis.

Bevan Lewis ("A Text-Book of Mental Diseases; Pathological Anatomy of General Paralysis," p. 566). Referring to spinal symptoms, this author groups cases into four arbitrary divisions. I will content myself with quoting in full his remarks in regard to the second group, comprising from the very onset notable tabetic symptoms:—"The cerebral symptoms are often so greatly in abeyance as to arouse the doubt whether we are not here engaged with a genuine tabes dorsalis of spinal origin. The disturbance of sensation, the abolition of the deep reflexes, the ataxic gait, are all so prominent that we are apt to attribute such symptoms to a primary implication of the cord itself. (This, I am sure, is the actual cause of the symptoms, and my own observations show that we should be right in thus accounting for them. F. W. M.) Yet in this tabetic form of general paralysis we must usually witness complete subsidence of the special spinal symptoms, the

tabetic gait passes off, the knee-jerk returns, and then the full development of the cerebral symptom is established, or what is not infrequent, the sensory implication of the cord becomes a motory affection, and the spastic paraplegia replaces the anæsthesia and ataxia. (My observation is that these clinical facts are right, and the inference wrong. F. W. M.) There has been a tendency to regard the later evolved cerebral derangements of typical general paralysis established in a well-marked tabetic case as due to an ascending change—that is, propagation by direct continuity of diseased tissue, thus making a system disease of the spinal cord the originating factor of the subsequent 'lesions of general paralysis." Dr. Lewis would look for the explanation rather through the vaso motor agency operating on nervous systems in physiological sympathy with their higher centres. I will discuss this point later, but with the first statement, that it is not an ascending change, I quite agree.

On page 319 Dr. Lewis states: "In tabetic forms of general paralysis the oculo-motor anomalies almost invariably precede the tabetic signs of abolished knee-jerk, and the pupils failing to dilate on shading or cutaneous stimulation, a paralytic myosis (moderate) eventually passes into a genuine spastic myosis from the irritation of a diseased process advancing upon the constrictor nucleus."

On page 322: "We may enumerate the association of a paretic or tabetic gait with the abolition of the deep reflexes and like irido-motor troubles. The tabetic gait occasionally associated with this absence of the knee-jerk is occasionally peculiarly disorderly, hurried, spasmodic, and insecure."

Régie ("Manuel Pratique de Médécine Mentale") says: "Since attention has been drawn to the mental state of tabetics, psychic troubles have been recognised more frequently in them; they are generally disturbances of intelligence and modifications of character which are revealed by irritability, bad temper, moroseness, hypochondriasis, depression and suicidal tendencies; at other times this may happen in the pre-ataxic stage; sensory troubles may be manifested, consisting of illusions, or more or less conscious hallucinations, principally affecting vision, hearing, or general sensibility; but the psychic disorders may not terminate here, and in certain cases insanity may co-exist. Pierret et Rougier, who have made a practical study of this insanity, have shown that more often it was a state of melancholia, with vague ideas of persecution and confused hallucinations. (A number of cases of this kind in my experience will be given later on. F. W. M.) The patients accused persons of wishing to poison

them, of making them burn; they complain of hearing that injuries will be done to them, of experiencing a bad taste in their food and in their mouth, of experiencing electricity in their limbs and disagreeable sensations; the delirium may present itself in the hypochondriacal form or in the ambitious form, as in general paralysis. Finally, tabes may be accompanied by enfeeblement of intellect, which may present great difficulties in distinguishing it from general paralysis. In some cases the disease assumes a hybrid form, and seems to be both tabes and general paralysis. The latter may be primary or consecutive to locomotor ataxy. When it begins thus by spinal phenomena it is given the name of ascending general paralysis. (This, I hold, is wrong. F. W. M.) This is the place to repeat that general paralysis and tabes are diseases absolutely similar as regards origin and nature, and that they have the closest relation to one another. It is not rare to see general paralysis begin or end by symptoms of ataxy, and in certain cases present during the course of the disease a mixture of spinal and cerebral symptoms."

Krafft-Ebing ("Progressive allgemeine Paralysie, Nothnagel's System"), one of the most energetic supporters of the syphilitic doctrine of general paralysis, strangely enough does not devote much attention to the relation of this disease to tabes dorsalis. On page 11 he refers, under motor disturbances, to tabetic symptoms in the form of temporary ocular paralyses, myosis and reflex pupil rigidity in the prodromal stage. On page 21 the disease of the spinal cord appears as "atrophy of nerve-fibres with consecutive development of connective tissue, and it may be looked upon as corresponding with the tabetic process. It is most strongly developed in Goll's column, and in the cervical cord is mostly limited to this tract. (Westphal.)"

On page 49: "The motor defects of the trunk and extremities are different in nature, and partly due to muscle insufficiency, partly ataxy, partly tremor. They arise in part from cortical changes, partly from pre-existing and complicating changes in spinal tracts. The gait may be paralytic, spastic, or ataxic."

On page 54: "In about 4 per cent. of the cases of paralysis, one finds tabic optic atrophy."

Page 73: "Often spinal cord changes, such as diseases of the posterior columns arising from the same predisposing cause—syphilis, whereby simultaneously or successively spinal cord or brain are affected. The tabetic process may come on with the paralytic or precede it." (He does not, however, mention it in the differential diagnosis. F. W. M.)

Sir William Gowers ("Diseases of the Nervous System," Spinal Cord, p. 466) says:

"Another very important and frequent complication of tabes is general paralysis of the insane. The two diseases have many alliances; it is probable that syphilis is the chief cause of general paralysis as well as of tabes. Reflex irido-plegia is common in both diseases; the two maladies are often combined, and the symptoms of one or the other may preponderate. Thus many general paralytics present symptoms of tabes, and its characteristic lesion is found after death. On the other hand cases of tabes may present slight symptoms of general paralysis, perhaps only slight optimism and mental weakness, which may remain subordinate or may increase to a pronounced or preponderate degree; it may be difficult to say in which category a case should be placed. It is sometimes said that a disease may commence as ataxy and change to general paralysis, but a more correct expression of the facts is a co-existence of the two affections and the dominance of the symptoms of one or the other."

Clouston ("Mental Diseases," 5th Edition, 1898, p. 390) considers:—

"The most marked variety of general paralysis is the peripheral form, where the pathological process does not begin in the cortex of the brain but in the cord (the tabic form), or in the neuronic portions of the organ of special sense (the sensory form), or in a peripheral nerve (the peripheral form) spreading upwards by pathological propagation along the connecting nerves in the lines of physiological function till it reaches the brain cortex. These varieties are rare, but distinct enough when they occur, and very interesting. They would seem to imply that the pathological process of general paralysis resembles the progressive Wallerian degeneration."

This assumption of Prof. Clouston is purely hypothetical; I have never seen degeneration of the fillet in the twenty-five cases of the tabic form of general paralysis which I have examined microscopically. If there were a progressive degeneration spreading up to the cortex along the path taken by the kinæsthetic impulses, there would be a continuation of the degeneration of the column of Goll, which was invariably present in all these cases, through the posterior column nucleus, the internal arciform fibres and the fillet; but this I have never seen. Neither have I seen any evidence in support of a process spreading up from the peripheral nerves; no doubt Dr. Clouston has put in a hypothetical way the so-called ascending form of general paralysis. This author refers to six cases of the typical tabic form which he has seen;

strangely enough in an otherwise admirable text-book he almost disregards the influence of syphilis as a causative factor in the production of general paralysis. He refers to the opinion of Dr. Drummond, of Newcastle, but surely the work of Fournier, and a large number of other Continental authors who have worked at this subject should not have been disregarded; and whatever Dr. Clouston's own opinion on this subject may be, in a text-book the other side of the question should have been stated, seeing that it is a prevailing opinion in England, America, and on the Continent, that, if syphilis be not the sole factor, it is the most important factor.

Möbius ("Ueber die Tabes," Berlin, 1897), in one of the most valuable monographs that has appeared on the subject, on page 6 of the introduction, points out that Türck, Baillarger, Simon, Westphal, Falret, Magnan, and others have studied both the clinical as well as the anatomical relations of the two diseases. However, it is only recently that the opinion has been advanced that really both diseases are of the same sort; that we call it tabes when especially the centripetal nerve-fibres are diseased, and general paralysis when especially the cerebral cortex is affected.

"This view is by no means accepted by all, still I maintain it is correct. Both diseases have the same cause, for both are meta-syphilis; in both there occurs a primary atrophy of nervous structures. Important symptoms, especially reflex pupil-rigidity and ocular muscular paralysis, are in both nearly equally frequent; in many tabetic cases, slight changes appear to be present in the cerebral cortex, which essentially resemble those of general paralysis. Still more frequently are spinal changes, loss of kneejerks, disease of the posterior columns present in paralytic patients. The tabetic cases come under the neurologists, and the paralytic cases under the alienists."

On page 31 on "The Brain Symptoms of Tabes," Möbius says:—"Attacks of migraine, epileptic attacks, apoplectiform attacks, and psychical disturbances may occur; it is, however, more correct to consider these complications as symptoms of progressive paralysis in tabetic patients. They represent an incomplete paralytic disease of the cerebral cortex, and they correspond to the transitions between the cases with isolated paralytic symptoms and those with undoubted progressive paralysis."

Marie ("Lectures on the Spinal Cord," Sydenham Society Trans., p. 292) says:

"The psychical derangements which occur in the course of tabes are not infrequent, but vary considerably; and Dieulafoy

was able to apply the term 'Tabid Insanity' to the condition which existed in some patients, while others present similar symptoms which are but slightly pronounced, and may be either transitory or permanent, or possibly occur in paroxysms (Fournier). He distinguishes the moral from the intellectual derangements the former he attributes more especially to the weak condition of the patient, and he remarks that notwithstanding the agonising pains the patients frequently feel, they are rarely found to commit suicide; while, on the other hand, in certain affections, notably those of the bladder, suicide is relatively more common. This is an interesting point in connection with the psychology of the tabic patient. (Both these symptoms are among the most frequent in tabes, and I have recollections of several patients who have attempted suicide on account of the pains and the miserable depression occasioned by an incurable disease, and accordingly been admitted to the asylum. F. W. M.) As regards the intellectual disorders, they are far less frequent, and if truly pronounced, depend upon the association of cerebral lesions with those of the spinal cord. Tabes is in that case most often found to be complicated by general paralysis of the insane. Such cases are rare, if not exceptional."

ETIOLOGY OF TABES AND TABO-PARALYSIS.

In the first volume of the Archives I gave a pretty full account of the literature in reference to the relation of syphilis and general paralysis both in the adult and juvenile form; since then, the percentage of syphilitic antecedents in general paralysis has attracted more attention in most of the London County Asylums, and I notice in the report of 1901 from Bexley Asylum that Dr. Stansfield gives 80 per cent. of the general paralytics with signs or history of syphilis. Dr. Thomas, of Hanwell, informs me that amongst the male admissions at Hanwell during the past eighteen months, 80 per cent. gave a syphilitic history. Dr. Bolton's statistics give similar results.

In 1863 Eisenmann and Topinard both expressed the opinion that syphilis was probably the cause of tabes; Westphal (1881), on the other hand, not only said that it was not proved, but it was not probable that syphilis was the cause of tabes. It was not until Fournier in 1876 brought

forward a series of thirty cases of tabes in which syphilitic antecedents were proved in twenty-four, that really attention was directed to the subject. As in general paralysis, so in tabes it was received with scepticism by the majority of the Vulpian supported Fournier, and the latter profession. collected more cases and in 1882 brought forward 103 cases of tabes, ninety-nine of which had suffered with syphilis, that is, over 90 per cent. Later he increased the numbers to 146, or 93 per cent. Erb in Germany, and Sir William Gowers in England collected cases, but it is especially the work of the former that has substantiated the doctrine of Fournier. Erb commenced collecting cases in 1879 and in the year 1897 his cases amounted to 900 of which 90 per cent. had suffered with syphilis. He found in 6,000 other nervous cases on the same basis only 20 per cent.

Westphal, Charcot and Virchow were always opponents of the doctrine, but the greatest opponent has been Leyden. Various authors have given different results. Very much depends on what each considers sufficient evidence to warrant the assumption of syphilitic antecedents. In a certain number of cases there is a history of a soft sore; in a large number it would be perfectly legitimate to consider this was syphilis, even if the secondary symptoms were so mild as not to have been noticed by the patient. In women, still-births and miscarriages or sterility would indicate probable, but not certain, syphilis.

STATISTICS RELATING TO SYPHILITIC ANTECEDENTS BY VARIOUS AUTHORS, AFTER REDLICH.

Buzzard			45 per cent.	Séguin			72 per cent.
Fränkel			50.7 ,,	Collins			75 ,,
Gerhardt		٠.	51 ,,	Friedheim			75 ,,
Bernhardt			60 ,,	Voigt			76 ,,
\mathbf{E} isenlohr			60 ,,	Rumpf			85 ,,
Mayer	• •	٠.	60 ,,	Althaus	• •	• •	90 ,,
Borgherini	• •		61 ,,	Raymond			90 ,,
Remak		• •	63.5 ,,	Strumpell			90 ,,
Gowers	• •		70 ,,	Dejerine			97 ,,
Mendel			70 ,,	Quinqu a del		••	100 ,,
Senstor	• •	• •	70 ,,				

There is a very considerable difference in the statistics of men and women as regards syphilis. Erb's statistics (1896) are in women 57 per cent. certain syphilis, and 30 per cent. highly probable. Minor published eight cases of tabes in women in all of whom syphilis was present. Redlich's are 23.4 per cent.

Max Nonne points out that as interest in this question was increased the authorities who had previously only found a small percentage of tabetic patients suffering with syphilis were led, as the enquiry progressed, to increase their percentages; thus Berger's statistics rose from 20 to 43 per cent., those of Bernhardt from 21 to 60 per cent., Oppenheim's from 17 to about 80 per cent., and Rumpf's 66 to 80 per cent. Minor's observations relating to tabes are also of great interest. He showed that among 4,700 non-Jewish Russians 2.9 per cent. were tabetics, on the other hand among 698 Jewish patients suffering with nervous diseases only 0.8 per cent. were tabetics. Functional nervous diseases are extremely common amongst the Jews, and yet tabes is comparatively rare. This may be explained by the fact that the Jews are much less liable to become infected with syphilis. Minor later showed that both tabes dorsalis and syphilis are five times as common among the non-Jewish Russians as in the Jews of Russia. (Among my cases there were three Two certainly had had syphilis and one tabetic Jews. probably. There were also three tabic paralytic Jews all of whom had signs and history of syphilis.)

STATISTICS OF SYPHILIS IN SIXTY-TWO CASES OF TABES DORSALIS.

In my own statistics there were forty-seven males and fifteen females. Of the forty-seven males, thirty-three (over 70 per cent.) had certainly syphilis, fourteen were doubtful, three owned to gonorrhea and two to soft sore; nine denied infection, but only one of these was able to say that he had not been in the way of getting it, and this man very possibly may have been the subject of inherited syphilis or have acquired it in some unusual way when young (vide

Case 1). In connection with this point I may mention that I had a patient not long ago under my care suffering with epileptic fits which were cured by mercury and iodide. The patient was aged 20 and I was informed that he had contracted syphilis when a little boy by being allowed to sleep with a shop assistant who suffered with the disease. Again, children may present no signs of syphilis on the body, and yet when a careful history is obtained, congenital syphilis can be proved to be the cause of a primary optic atrophy (vide Case 74), juvenile general paralysis, or tabes.

Again, as an example of syphilis acquired in an unusual manner, I will cite a series of ten women infected in child-hood by a midwife (*Lancet*, p. 402, 1895). Also, a number of glass blowers at St. Helens suffered with chancre of the lip. Many people are infected and never know they have suffered with the disease; but a larger number know and will not own up.

STATISTICS OF SYPHILIS IN SIXTY-TWO ASYLUM CASES OF TABO-PARALYSIS.

Of fifty-four male tabo-paralytics and insane tabetics, forty-six of which were personally seen and examined by me, there was a reliable history, or signs on the body, of syphilis in at least 75 per cent. In four cases there were no notes obtainable, and I did not see the cases during life. In four there were doubtful signs or history. In only one case was there no history of syphilis, no signs on the body, and a healthy family, but as everyone knows, this does not absolutely exclude a syphilitic infection. In the remainder syphilis was probable, or could not be excluded.

There were eight women. In only two were there definite signs on the body; the history, however, of the remaining six made it almost certain that they had been infected. One was probably a "puella publica" without friends. Another was a kept woman who had previously suffered with venereal disease, and had had several miscarriages. The remaining four had husbands who suffered with tabes or general paralysis themselves (vide pp. 18, 19).

BIRTH AND DEATH RATE OF TABIC AND TABO-PARALYTIC PATIENTS.

Twenty-six tabetic men were married, and had eighty-six living children, forty-seven dead, twelve born dead, and twenty premature births. Several were infected after marriage, and then followed miscarriages and dead children. It will be of interest to contrast the death rate of the children of ataxic patients of the two sexes.

Amongst the fifteen females, fourteen were married women. Four of these were sterile, and had no premature births; all gave a definite history or signs of syphilis on the body. Of the others one had a living child after ten years of married life; she did not know that she had had any miscarriages, and there were no signs of syphilis on the body. Of the remaining nine, three had certain signs and history of syphilis, but all the nine had miscarriages, stillborn and dead children. One woman was unmarried, and there was no history or sign of syphilis. The record of the fourteen married women as regards children was as follows: Four had no children and no miscarriages; ten had amongst them (each contributing, so that every one was capable of conception and of child-bearing) six living children, sixteen miscarriages, fourteen born dead, and four dead in infancy.

The eight females had amongst them sixteen miscarriages or premature births, eight children dying in infancy, and ten children living, but the eight children dying in infancy, and five of the living children were contributed by one woman.

The married male tabo-paralytics were thirty in number, and had sixty-eight children alive, twenty-six children dead, and twenty-seven miscarriages or born dead. If we contrast these statistics of tabo-paralytics with the tabetic cases we find that they have fewer healthy and dead children. This is because they do not live so long after infection as the tabetics, moreover after removal to an asylum no further conception takes place, otherwise there is the same close similarity between the hospital and asylum cases. Adding the fifty-four males married, suffering with tabes or tabo-

paralysis together, and contrasting them with the twentytwo married females, we find a remarkable contrast, showing that when the female is infected, the chance of living children being born is greatly reduced; correspondingly, there is an increase of dead children and miscarriages.

	Children alive.	Born alive, but died in infancy, or afterwards.	Born dead.	Miscar- riages.
Twenty-two married females, suffering with tabes or tabo-paralysis. Seven of these were sterile.	10	10	18	31
Fifty-four married males, suffering with tabes or tabo-paralysis.	151	75	52	

Several male cases were of interest because of a definite history of infection occurring after marriage: in these cases, miscarriages and abortions followed healthy children. It will be seen that very nearly 30 per cent. of the married women were sterile. Mendel found that in 252 married female tabetics 32.9 per cent. were childless.

STATISTICS RELATING TO GENERAL PARALYSIS IN WOMEN.

By kind permission of Dr. Stansfield I am enabled to publish the following data from statistics furnished by Dr. Hubert Bond:-

E. Mendel. "Die Tabes beim Weiblichen Geschlecht," Neurol. Central-

The text-books teach that tabes occurs much more frequently in men than women: e.g. those of Obersteiner and Redlich, v. Leyden and Gold-

Kowshewnikoff 11: 1, Moczutkowsky, quite recently 15: 1, Fournier 26: 1, Kowshewnikoff 11: 1, Moczutkowsky, quite recently 15: 1.

Mendel's statistics at his Polyclinic in Berlin:—Number of patients 20,539 males, 21,825 females; total 42,464. Of these there were 725 male tabetics, that is 3:53 per cent., and 288 female tabetics, that is 1:31 per cent.

There was, therefore, one tabetic woman to 2.7 tabetic men.

He comes to the following conclusion. One can therefore say that the frequency of tabes in the female sex is essentially the same as progressive paralysis among the poorer classes, where about one paralytic woman to every three men occurs; whilst in the well-to-do the relationship is improved five to ten. Tabes occurs at a somewhat later age on an average in women than men, the greatest frequency being from 40 to 45 years. Of the 288 cases, 252 were married women, and thirty-five unmarried. Of the 252 married women, eighty-three were childless, 32.9 per cent. Kron found among thirty-three married tabetics ten sterile, 30 per cent. According to Guttstadt's figures which agree with those of Mendel, 10 per cent. to 15 per cent. of sterile marriages occur among the same classes of non-tabetic married

Of seventy female general paralytic cases there were fifty-two married women; six cohabited with men; four were juvenile general paralytic cases; one was imbecile; seven were single women.

Dr. Bond obtained the very high percentage of 34 out of 70 with certain history or signs pointing to syphilis, and ten doubtful history.

The following data were obtained from statistics kindly furnished me by Dr. Bailey, of Hanwell, relating to 118. female general paralytic cases:—

Of 118 female general paralytics there were 102 married women; two juvenile general paralytic cases; three certainly had cohabited; eleven single, (?) virgins.

The 105 women had 129 children alive, 117 children born alive but dead = 2.3 per cent.

Of these women 34.5 per cent. were sterile, which is almost identical with Mendel's statistics regarding tabetic women.

Dr. Bailey's statistics do not show more than 20 per cent. with a history or signs of syphilis on the body.

This sterility may be explained by the fact that conception had not taken place, or that the embryo had died in the first month or so after conception.

Statistics of Spencer Wells, Simpson and Sims, as well as of Guttstadt, show that married women are childless in 10 to 15 per cent. In female tabetics and paralytics sterility is nearly three times as frequent as the average. In England the average number of children born alive for each married woman is 4.5. It will be found that this corresponds nearly with the male tabetics and tabo-paralytics; but with the females suffering with this disease it is less than one for each.

That we cannot prove more than between 70 to 80 per cent. of tabic and paralytic patients to have suffered with syphilis is no argument against the doctrine that both paralysis and tabes are post-syphilitic affections. Dr. Crocker has shown that in not more than 80 per cent. of true specific skin diseases can a history of syphilis be obtained. In sixty cases of syphilitic brain disease I could not obtain a history in more than 70 to 80 per cent. The very important experi-

ence of Jadassohn and Hirschl, that only in one-half of the cases of undoubted severe syphilis is it possible to prove primary infection, and the statement of Lang that in one-third of the cases of tertiary syphilis the primary infection was not demonstrable, are arguments against those who will not be convinced that syphilis is the essential cause of tabes and general paralysis unless it can be proved in every case.

CONJUGAL TABES AND PARALYSIS.

Mendel, a supporter of the view that syphilis is the most important cause of tabes and paralysis, published in the Neurologisches Centralblatt (1888) five cases of paralysis and tabes occurring in married couples; and Dr. Raecke, in the Monatschrift für Psychiatrie und Neurologie, vol. 6, published seven of his own cases, and he gives a table with complete literature of sixty-nine cases.

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In 38 cases, syphilis certain.

,, 11 ,, ,, probable.

,, 2 ,, ,, denied.

,, 18 ,, ,, unknown facts, but probable syphilis.

Paralysis in both husband and wife occurred in 27 cases.

Tabes ,, ,, ,, ,, 22 ,,

Paralysis in man and Tabes in wife ,, 14 ,,

,, wife ,, ,, husband ,, 6 ,,

69
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This result agrees with Mendel's statement that "if each of the couple suffer with tabes or paralysis, the man is more frequently affected with paralysis." The author also shows that the man as a rule suffers before the woman; the reason is obvious—the man is affected with syphilis first, and is therefore more likely, but not certain to develop the syphilitic degenerative affection. Out of twelve cases of tabes in husband and wife the man was affected first in seven.

Dr. Moenkemoller ("Ueber Conjugale Paralyse bezüglich Tabes," Monatschrift f. Psych. u. Neurol., 1900, Bd. viii.)

found that in 741 paralytics admitted to Herzberge Asylum during six years, there were seventeen cases of conjugal paralysis or tabes. Of these seventeen cases, in fourteen both husband and wife were affected with paralysis; in seven of these, however, one or other suffered with tabo-paralysis; and in two the husband suffered with tabes and the wife with paralysis; in one the husband suffered with paralysis and the wife with tabes. The husband was first affected in thirteen cases; in three cases husband and wife simultaneously; in one the woman was affected first—she was a "puella publica." The proportion showing a history of syphilis is not reliable, owing to the fact that the notes were made at different times by many observers. The statistics are, however, of interest, as showing that the husband is almost invariably affected first; and that the proportion of married couples affected is about 2.5 per cent. This percentage corresponds very closely with the average number of persons affected with para-syphilitic affections.

One of the cases recorded was especially instructive. The husband was infected in 1876. Married in 1879. The wife in 1880 gave birth to a daughter who was syphilitic. In 1894 the husband first showed signs of tabes. In 1895 the daughter first showed signs of paralytic dementia and in 1897 the wife was similarly affected.

My own cases furnish the following results of affection of Married Couples:

Case.		History of Syphilis.	Age and Onset.	Interval between af- fection of husband and wife.
1	Wife, Ataxy. Husband, Paralytic.	Miscarriages, no living children. Pigmented scar. Indirect from wife's history.	45. Onset with Charcot's joint gastric crises. 35. Death at 36.	10 years, hus- band affected first.
2	Wife, Tabo - paralysis. Husband, General Paralysis probable, as he had suffered with fits and died insane.	Sterility. Husband, soldier in India.	35. Optic atrophy. Age? Affected after his wife went blind.	?

Саве.		History of Syphilis.	Age and Onset.	Interval between af- fection of husband and wife.
3	E. E. G., Wife, Tabo-Paralysis. Husband, Tabo- Paralysis.	Serpiginous pig- mented ulcer on leg. Five still- born or miscar- riages. Four children died in infancy. Seven alive. No signs of Syph- ilis noted in hus- band, who died at another asylum.	62. With mental symptoms. Came on after her husband had been taken to the asylum. 60. Blindness, a tax y and mental symptoms.	2-3 years, hus- band affected first.
4	Wife, General Par- alysis. Husband, Tabo- Paralysis.	Child by first husband, sterile by 2nd (Syphilitic) husband. Scar of chancre and indurated glands, papery scars.	35. Worried about husband. Mental symptoms, delusions and hallucinations. 41. Opticatrophy. Ataxy, then mental symptoms.	2 years, husband affected first.
5	Wife, Ataxy. W.F., Husband, Tabo-Paralysis.	One child born dead. Scar of chancre, in- durated glands.	Ataxy. 40. Mental symptoms and ataxy.	Simultaneously or nearly so.
6	L.H., Wife, Tabo- Paralysis. Husband, General Paralysis or Pseudo G.P.	Three miscarriages, said her husband gave her Syphilis.	 53. Mental symptoms and ataxy. 54. Dementia. Spinal affection and paresis. 	1 year after hus- band.
7	Wife, General Paralytic. E.C.R., Husband, General Paralytic.	Syphilitic psoriasis. Leuco-placia. Gumma of tongue. Indurated glands.	87. 52. Grandiose delusions, dementia, paresis.	Wife admitted to Cane Hill one year after husband had been admitted to Claybury.

In all these cases it is probable that the husband infected the wife. In only three cases were the husband and wife both seen. In the remaining four one or the other was seen personally. In all seven it may be presumed that the husband suffered with syphilis and infected the wife; in five out of the seven the symptoms commenced certainly

in the husband first. Syphilis, or signs of it, were observed or indicated in either husband or wife in every case with the possible exception of Case 64 (vide p.-m. notes), but the chances of a man being infected who has been a soldier and served in India 1 are very great.

The above cases I have merely come across while making this research on tabo-paralysis, but probably a careful analysis of all the general paralytics admitted into the London County Asylums would show, like Moenkemoller's statistics, conjugal affection in about 2 to 3 per cent. of married general paralytics. This conjugal affection becomes an important argument in favour of (1) the syphilitic origin of the disease; (2) the effect of mental strain and worry in inducing the disease in one of its several forms; (3) the fact that one of the pair may be affected with tabes and the other with paralysis or tabo-paralysis, supporting the view of the unity of the two diseases engendered by the action of the syphilitic poison.

In the juvenile form of general paralysis I have found six out of thirty-two in which one or other of the parents had died of the same disease; in at least 80 per cent. of these thirty-two cases, there were signs on the body or a definite history pointing to congenital syphilis, and in the remaining 20 per cent. it was so probable that one might conclude that probably every case was of a syphilitic origin. Dr. Tredgold found among his imbecile cases six juvenile paralytics, and all of these were syphilitic cases. Seeing that sexual excesses, alcoholism, and other causes to which general paralysis is attributed must play quite a subordinate part in these cases, it must be assumed that inherited syphilis is the essential factor. Three of the total juvenile general paralysis cases (about 10 per cent.) were of the ataxic form, and a considerable number commenced with optic atrophy and blindness long before the mental symptoms developed.

Occasionally one member of a family suffers with tabes

¹Venereal Diseases in the British Army, B.M.J., July 27, 1901. The Secretary of State for India said that 522 per 1,000 of the British Army had been admitted into hospitals for venereal diseases in 1895, 313 per 1,000 in 1899.

and another with general paralysis, e.g. (1) two brothers in two instances; (2) brother and sister in one instance; (3) father, general paralytic; child, congenital syphilis and tabes with optic atrophy. Cases such as these indicate an hereditary soil, or temperament, suitable for the poison to act in producing the degenerative process.

In two of my cases of tabes there was a history of congenital syphilis, and in one at the age of twenty, optic atrophy and absent knee-jerks appeared, which suggested congenital syphilis as a cause, although there was no history of it (vide Case 1).

Remak has described three cases of tabes in children; in two there was certain hereditary syphilis, and in one probable; the father of the third likewise had tabes.

Goldflamn has described one case of acquired syphilis which developed tabes and also had several children who suffered from the disease. Strumpell described taboparalysis in a 13-year-old girl with hereditary syphilis. Gowers' two cases had both hereditary syphilis. two cases both hereditary syphilis. Fournier described four cases, certain syphilis in one, and probable in the other Bloc and Gilles de la Tourette each one, with certain syphilis; and Erb three pairs of sisters, six cases of tabes in all, in whom hereditary syphilis was demonstrable. Gowers, Fournier, Raymond, Homen and others have described cases of tabes in adults as the result of hereditary syphilis, and Nonne ("Syphilis und Nerven System," 1901, p. 322) also gives one of his own observations, which is most striking. as follows: "A workman aged 32, who had suffered for two years with lightning pains, and had never been infected with syphilis or addicted to drink, presented all the typical signs of ataxy. He had been treated in the hospital for severe hereditary syphilis." I have occasionally noticed the same in general paralysis commencing in adult life. In my Croonian lectures I remarked that it is possible that some of the cases occurring in adults in which no history of acquired syphilis can be obtained, may still owe the disease to an inherited taint. It is not even necessary that they should show external signs of syphilis, for many of the cases of juvenile general paralysis were proved to be born of syphilitic parents, although manifesting themselves no external signs of syphilis; whereas their brothers or sisters might exhibit well marked signs. A case of general paralysis died at Banstead Asylum, which had previously been under the care of Dr. Percy Smith at Bethlehem Hospital. The woman had characteristic signs of general paralysis, but she did not manifest symptoms of progressive dementia until she was 30 years of age. The patient was an unmarried woman, and there was no reason to believe that she had acquired the disease.

POST-MORTEM TABLE RESULTS IN REFERENCE TO SYPHILITIC RESIDUA IN TABES, COMPARED WITH THE POST-MORTEM RESULTS IN TABO-PARALYSIS AND GENERAL PARALYSIS.

Westenhofer examined the bodies of seventy-two cases of tabes at Virchow's Institute; in 44 per cent. certain or doubtful syphilitic signs were observed. These results compare very closely with those I have obtained in general paralytics; for in 213 male post mortems at Claybury Asylum in 1900 and 1901 there were eighty-six general paralytics, and 45.4 of these had signs of syphilis on the body; in the remaining 127, 9 per cent. had certain or doubtful signs of syphilis on the body. In the post mortems made on 249 females, there were thirty-six general paralytics; and of them 19.5 per cent. had signs of syphilis on the body. Of the remaining 213, only two (less than 2 per cent.) showed signs of syphilis. The frequency of non-tubercular salpingitis in female general paralytics is also an indication of the greater frequency of venereal infection in these women. It suggests also that a number of these may be recruited from women who had previously led an immoral Dr. Bolton's statistics show that out of eighteen general paralytics dying at Claybury fourteen (or 77 to 78 per cent.) showed former non-tubercular tubal disease, whereas in ninety-two other cases only 10 or 12 per cent. showed former non-tubercular tubal disease.

These results are undoubtedly favourable to the syphilitic

view if we consider how often syphilitic lesions heal up in women and disappear, leaving no certain trace behind. In one tabo-paralytic woman there were no external signs on the body; she was sterile. At the autopsy I found a scar on the os uteri the size of a threepenny piece.

RACIAL SYPHILIS IN UNCIVILISED COUNTRIES IN RELATION TO TABES AND GENERAL PARALYSIS.

It is asserted that in countries where syphilis is extremely common—Bosnia, Herzegovina, Algeria, Abyssinia and Japan 2—tabes and general paralysis are extremely uncommon or never met with. Egypt was cited formerly, but the statistics of Dr. Warnock, of the Abassieh Asylum, Cairo, show that 6 per cent. of the inmates are general paralytics, and in a recent report he states that syphilis is demonstrable in the great majority of these cases; moreover, he considers it the essential cause of the disease. When I visited Jamaica I ascertained that a large amount of syphilis existed among the negro population; it had become very rife since numbers of them had returned from

At a recent meeting of the Société de Neurologie of Paris, M. Scherb, of Algiers, gave an account of his observations on syphilis and nervous disorders in the Arab, made during three years' residence in Algiers. Tertiary syphilitic in the Arab, made during three years' residence in Algiers. Tertiary syphilitic symptoms, both cutaneous and osseous, were more frequent among the Arabs than among the Europeans (of Algiers). The rarity of cerebral syphilitic accidents and of para-syphilitic manifestations (tabes and general paralysis) is attributed to the fact that syphilis is a disease of comparatively recent importation among the Arabs of Algiers, and that its stress falls with peculiar vehemence in the tertiary period on the cutaneous and osseous structures. It may be added that the people are essentially lazy, taxing their brain and nervous system but little, and that the organ which is thus least taxed is also the least exposed to the injurious effect of syphilis. The absence of a special predisposition produced by syphilitic or other stresses, however, is not one likely to persist; for with the increase of civilisation and of alcoholism the Arab is preparing himself a neuropathic soil for the future development of Arab is preparing himself a neuropathic soil for the future development of both tabes and general paralysis. It is pointed out that other indigenous Semitic races (Jews) present both tabes and general paralysis not infrequently, and they undoubtedly present the neuropathic basis for the development of those affections. In the discussion following the above communication Professor Raymond pointed out that among the Abyssinians syphilis was not uncommon, but it did not produce nervous diseases secondarily. (Brit. Med.

uncommon, but it did not produce nervous diseases secondarily. (Brit. Med. Journal, Sept. 28, 1901.)

² Dr. S. Nose, "Beitrag zur Tabes Syphilis Frage," Neurol Centralblatt, 1901. Mittheilungen der Medicin Facultät der Kaiserl. Japanischen Universität in Tokio. Ninety-six cases of tabes dorsalis, eighty-three males and thirteen females. (1) Forty-six cases certainly syphilitic = 47.9 per cent.; ten cases probably syphilitic=10.4 per cent. (2) Without demonstrable syphilitic infection (a) Without gonorrhœa twenty-four cases=25 per cent.; (b) With gonorrhœa fifteen cases=16.6 per cent.

Panama. Dr. Henderson, of Kingston, informed me that tabes was uncommon; but I found at the asylums many cases of general paralysis; and Dr. Plaxton, the Superintendent, told me the latter was common. I examined there several women suffering with this disease.

On the other hand, in Iceland and the rural districts of Ireland and Sweden syphilis is very rare or unknown, likewise tabes and general paralysis; again, the comparative absence of the diseases, tabes and general paralysis, in priests, Quakers, and women of the better classes in whom syphilis is rarely met with, but where all the secondary or contributory causes occur just as frequently as in other classes of society, tends to support the view that syphilis is an essential factor. We can only reconcile the two contradictory facts that races free from syphilis are free from tabes and paralysis, and that races extensively syphilised do not suffer from these two diseases, by supposing that other contributory factors are absent in the latter, viz., mental stress combined with an emotional, lustful, neurotic, neuropathic or psychopathic temperament, especially when assisted by indulgence in alcohol. Excesses in baccho et venere are not only powerful agents in the production of tabes in all its forms, but also in hastening the progress; exposure to cold and wet, also injury, may act as contributory factors. We will now consider each of these causes separately.

Stress.—Prof. Edinger has emphasised the importance of stress in determining the seat of the degenerative process, and he has shown by experiment that degenerative changes in the posterior column of the cord can be induced in animals rendered anæmic by a poison like pyridin, if these animals are daily made to use their limbs for a certain time so as to produce artificially stress of the nervous structures concerned in locomotion. My experience certainly shows some instances in which occupation has apparently determined the seat of the lesion. The occupation of sixty successive male cases of tabes dorsalis met with in hospital practice or outside the asylum, showed only two that were not laborious, involving stress of the

lower limbs. There were two clerks and one of these suffered with cervical tabes, and in the other the arms were early affected and the patient subsequently became a tabo-paralytic case. A mounted policeman was first affected in the arm with which he held the reins. Two packing-case makers, a carpet planner, a parcel-post sorter, were early and markedly affected in the arms. Two tailors were only affected in the legs, but they worked a treadle sewing machine. A carpet planner who knelt all day suffered with tabo-arthropathy of both knee joints, whereas a stone mason who wielded a 4lb hammer in his right hand, and a chisel in his left, suffered with a Charcot's joint of the right shoulder and arthritis of both hands, and of the left elbow. Among the fifteen women a large proportion had to earn their living by charing, which means kneeling or scrubbing, or else they worked a sewing machine; and this may account for the frequency with which they suffered with tabic-arthropathy affecting one or both knee joints. Of the fifteen women seen in hospital practice, seven suffered with Charcot's joints. and in six out of seven it was the knee. Of the fifty-four men there were only five who suffered with joint affections. Among the tabo-paralytics, there were eighteen in which cord symptoms were known to have preceded mental symptoms, and only two of these did not follow an occupation involving stress on their lower limbs.

Mental worry and strain.—In many of the cases of taboparalysis mental worry seems to have preceded the development of the brain symptoms. Not infrequently the blindness from which the patient suffered was a cause. Exposure to cold and wet were often assigned as causes, likewise unequal temperature of the anterior and posterior surfaces of the body, as in men working at a forge, engine drivers and stokers, but as a rule these were only contributory factors of minor importance. According to Erb in only 1.4 per cent. of cases may exposure to cold and wet be considered primary causes. Injury to the spine in four cases was thought by the patients to be the cause of their affection; it certainly seemed that the disease came on after the injury, but would it not have done so without?

In all the traumatic cases save one there was a definite syphilitic history. Klemperer collected from various sources of literature, thirty cases of so called traumatic tabes, but Hitzig in a valuable monograph has dispossessed Klemperer's inferences of much of their import. Hitzig showed that but few of Klemperer's cases were genuine traumatic tabes. Erb gives the percentage as 0.3, Leyden and Goldscheider say that it is not considerable. It is true that trauma may, as in general paralysis of the insane, act as a contributory factor.

Hereditary Predisposition.—I do not think this plays such an important part in tabes as in general paralysis. Charcot, Ballet, Benedikt, and Borgherini considered it an important factor in tabes; Rosenblatt, Raymond and Fournier, Erb and Gowers as a contributory factor of some importance; Leyden as an effective agent. Redlich attaches no very important rôle to hereditary influence, scarcely more than a contributory factor. In considering hereditary influence we should not only take into consideration nervous and mental diseases in ancestors, but also temperament, which may mean potential neurosis or psychosis. Among the tabo-paralytics and tabic cases suffering with insanity met with in Asylums, 30 per cent. had a family history of insanity. In his Presidential Address to the Medico Psychological Society Dr. Wiglesworth pointed out that hereditary influence plays a much less important part in general paralysis than in other forms of insanity. This was confirmed to me by Drs. Savage, Craig, Spencer, Woods and others.

Intemperance.—In twenty-six asylum cases there was a reliable statement obtained that the patient was not in any way intemperate, and it was concluded that drink as a contributory factor in these cases had no share. In sixteen cases out of sixty it was concluded that drink was a contributory factor of some importance; and in the remainder, no definite reliable statement was obtainable. In a good number of cases the wife's statement was that the patient was a good husband and a good father. I came to the conclusion that drink played a more important part in

tabo-paralysis than in tabes; but that in both it was not such an important factor in the production of the disease as in accelerating its progress. Frequently intemperance and lust is the first evidence met with of the degenerative process affecting the brain or cord.

Mode of Onset of Tabes and Tabo-Paralysis.

Onset of tabes dorsalis. In sixty-five cases the average age at which the onset of symptoms occurred was thirty-seven. The average interval between a definite history of infection and onset of symptoms was ascertainable in more than half of the cases, and was fifteen years. The shortest period was four years and the longest twenty-six. The average age of onset of the disease in the different decades was as subjoined; the age of most cases was determined by the history of some characteristic subjective symptom or group of symptoms, such as pains, double vision, visceral crises, or of the first objective manifestation, &c.:

In sixty per cent., shooting pains were the first symptom which attracted the patient's attention.

In 12.3 per cent., double vision was the first symptom which attracted the patient's attention.

In 14 per cent., visceral, especially bladder troubles, and gastric crises were the first symptoms which attracted the patient's attention.

In 10 per cent., arthropathies or spontaneous fracture.

In 10 per cent., failure of vision and blindness.

The youngest age, excluding a probable congenital case, was 25, the oldest 55.

DECADES AT WHICH THE ONSET OF SYMPTOMS OCCURRED.

				Tabes	Dorsalis.		eneral Par- 118 cases.	Tabo-	Paralysis.
1st d	ecad	le	 	1.21 p	er cent.				
2nd	,,		 	1.51	,,	1.75 p	er cent.	6 p	er cent.
3rd 4th 5th	,,		 	8.5	,,	1.75	,,	4	,,
4th	,,		 	47.1	,,	47.45	,,	72	,,
	,,		 	32.3	,,	39.	,,	20	,,
6th	,,		 	13.3	,,	8.5	,,	6	,,

¹ Congenital Syphilis.

Onset of the tabo-paralytic and general paralytic cases was more difficult to ascertain with preciseness, because of the mental condition of the patients, and because of the difficulty to exactly fix the date of onset of mental infirmity; but, generally speaking, the above tables closely correspond, for nearly all the cases begin in the fourth and fifth decades, on an average fifteen years after the period of greatest probability of infection, viz., between 20 and 30. Of fifty-four cases of male tabo-paralysis, the average age of onset of symptoms worked out at 381. These figures were raised quite one by the existence of a man and his wife whose symptoms (sufficient to attract attention) apparently only commenced at 62 and 63 respectively. The interval of time between infection and onset of symptoms could only be precisely ascertained in fourteen cases; this was partly due to the unreliability of the answers given owing to the mental condition of the patients, and partly, as in the spinal tabetic cases, to the fact that the patients denied, or did not know that they had had syphilis, although there was positive evidence on the body. The shortest interval was six years, the longest twenty-five; average, as in tabes dorsalis, fifteen years.

An argument that is frequently used against syphilis being the cause of tabes or general paralysis in one of these many different clinical types is the fact that there are not more prostitutes affected. Since the great bulk of the cases occur, as we have seen, in the fourth and fifth decades, when it is not so easy for a woman to earn her living by prostitution, she is not described as such upon entering the asylum; and I have found a number of such women in the asylums calling themselves married women, or as following some occupation. Occasionally, indeed, they are described as single women, and in many instances it is subsequently proved (as Case 31) that they have led an immoral life.

Kron's observations upon 184 public prostitutes showed five with tabic symptoms at ages of 27, 28, 47, 47, and 55. But if one reckons only with those over 25 years of age, which allows nine years for the onset of the disease after

i - 1 -

infection, there were only thirty-six women, and of these five suffered with tabic symptoms; or 14 per cent. of syphilitic prostitutes suffered with tabes, which is far from a low average. ("Ueber Tabes Dorsalis beim Weiblichen Geschlecht," Deutsch. Zeitschrift fur Nervenheilkunde, Bd. xii., 1898.)

In thirty-four cases it was possible to determine the age of onset of the spinal and mental symptoms respectively. Average age of onset of spinal symptoms, the most frequent being lightning pains, was $37\frac{1}{2}$; average age of onset of mental symptoms was 39½. Probably this is too late by several years, for early slight changes of character, irritability of temper, moroseness, &c., are easily overlooked. The longest interval between optic atrophy and mental symptoms was eighteen years. In one half of the cases the spinal and mental symptoms were apparently simultaneous, and the cases frequently, but by no means invariably, ran a rapid course; in some instances they terminated fatally within six to eighteen months of onset of symptoms. In forty-eight cases it was possible to determine whether the spinal signs and symptoms were observed first, simultaneously with, or successive to, the mental symptoms. In twenty-four cases signs of brain affection either preceded or were simultaneous with signs of affection of the cord or eyes, or both. Fournier ("Affections Parasyphilitiques, Tabes et Paralysie Generale," p. 213) says: "Tabes and general paralysis will be different expressions of one and the same morbid entity." He further on asks the question, "Is one authorised to fuse into a single morbid entity tabes and general paralysis?" He sums up the identical relations of the etiology, the close relationship and overlapping in the symptomatology and pathology, and destines them one day or other to be grouped in a single pathological entity.

The foregoing pages on the etiology of spinal and cerebral tabes, clinically distinguished as tabes dorsalis and general paralysis of the insane, tend to show that, pathogenetically, the two diseases are identical. I will next endeavour to show a close clinical and pathological relationship of the different types of a single pathogenetic morbid entity.

SYMPTOMATOLOGY.

The fundamental symptoms and signs of tabo-paralysis and of tabes are:—(1) Reflex pupil rigidity; (2) Lightning pains; (3) Absence of deep reflexes; (4) Visceral disturbances, bladder troubles, and gastric crises; (5) Disturbances of sensibility; (6) Motor disturbances; (7) Mental disturbances.

A diagnosis can be made, if the pupil rigidity exists, combined with any of the others, for, practically speaking, reflex rigidity of the pupils to light and pain exists only in tabes, general paralysis, and acquired or congenital syphilis, of which (as pointed out by Sir William Gowers) it may be the sole sign. Very rarely cases of focal cerebral lesions may be accompanied by Argyll-Robertson pupils, especially lesion of the corpora quadrigemina. Some authors point out that in alcoholism and other diseases reflex rigidity of the pupils may exist, but these are cases complicated by syphilis. Indeed, the existence of reflex rigidity of the pupils is evidence that a mania à potu is due not only to the toxic effects of the alcohol, but also to general paralysis. The value of this sign is shown by the fact that in thirtytwo cases of tumour cerebri found on the post-mortem table at Claybury, the notes showed that in only one case was there reflex rigidity of the pupils to light, and this was a syphilitic case with general paralysis. Yet on account of progressive dementia and other mental symptoms, and not infrequently failure to discover or even absence of the cardinal symptoms of tumour (optic neuritis, headache, and vomiting), more than one half of these cases were diagnosed as general paralysis. As a rule, we do not know how long the Argyll-Robertson pupil has been in existence, for, of course, the patient is unaware of its presence, and only comes under observation when some other early symptom such as pain, a fit or mental symptoms, double or defective vision, visceral crises, or ataxy brings him to the doctor.

EYE SYMPTOMS OF TABES AND TABO-PARALYSIS.

Pupil changes are met with in nearly all cases of tabes and tabo-paralysis, and in the majority of cases of general paralysis, in the earlier or later stages of the disease. The hospital cases of tabes closely correspond to the asylum cases of tabes and tabo-paralysis as regards pupil phenomena, as the subjoined statistics show.

	Tabes or Tabo-Paralysis (Asylum Cases).			
73.5 per cent. 3 3.7 15	Argyll-Robertson pupils on both sides one side sluggish to light	••	70 per cent. 7 ,, 4 ,, 20 ,,	

Occasionally in tabes and more often in tabo-paralysis and general paralysis, paradoxical reaction to light occurs; viz.: on removal of the shadowing hand no reaction takes place for a second or two, then the pupils dilate slightly. Möbius explains this phenomenon thus: that probably during the process of covering the eyes, the patient is accommodating, and when the shadowing hand is removed, accommodation is relaxed, the process of accommodation being a slower process than the light reflex. A sluggish reaction to light is not necessarily pathological, and unless there is a difference between it and accommodation, it may be of no import. With absence of the light rigidity, there is nearly always absence of reflex cutaneous pain, and it is not uncommon to see a patient suffering agonising pain with pin point pupils.

INEQUALITY, IRREGULARITY AND SIZE OF PUPILS.

Before the discovery of the Argyll-Robertson phenomenon, inequality of the pupils afforded a valuable sign of the disease; likewise very small pupils; and even now such alteration may attract the physician's attention, and lead to his making a more careful examination of a case which presents urgent symptoms pointing to organic disease of internal organs; e.g., in Case 7, which was admitted for acute intestinal obstruction, the surgeon who was called in to operate had his attention attracted to the very small

^{&#}x27; Most of the cases which were totally inactive to light and accommodation were the subjects of complete optic atrophy.

pupils, while the man was suffering agony, and this led to the discovery of the true nature of the disease. Inequality of the pupils is more frequently met with in tabo-paralysis and general paralysis than in tabes.

Size, Inequality, 1	Size, Inequality, Irregu- larity of Pupils in Tabo- Paralysis (Asylum).						
Unequal 1			40 pe	r cent.		65 p	er cent.
Irregular		•••	18.5	,,		27	,,
Small			32	"	•••	33	"
Pin Point		•••	18	11		16	"
Medium	•••	•••	34	,,	•••	33	,,
Large on one o	16	••		18			

Paralysis of the external ocular muscles may be transient or permanent. Diplopia (double vision) is often the first subjective symptom which attracts attention; but it may be due to a syphilitic meningitis. In several of my cases it occurred within a few years of the syphilitic infection, but as a rule the interval is much longer. Any muscle may be affected, but the external rectus is the most frequent. The patients often complained of double vision, which lasted a few days or weeks, for which they attended an eye hospital long before the other symptoms troubled them. Some of these cases were sent on to me from the Westminster Ophthalmic Hospital, or by my friend, Mr. Treacher Collins, from Moorfields.

Ocular paralysis in the hospital cases, a considerable number of which, however, were sent from the eye hospitals, render the following statistics much too high.

In twenty-two there was double vision of a transitory nature; it was, in nearly all the cases, a very early symptom. There were nine cases of ptosis (in four associated with squint) and four of

These figures are only approximate, as a number of cases were only seen once or a few times. The series contained a considerable number suffering with optic atrophy or blindness. Irregularity of the pupils may occur independently of synechiæ, the pupil being angular, elliptical or oval; it was more frequently met with in the asylum than hospital cases. The asylum cases, as a whole, came more frequently under my observation, and I was able to note the fact that the degree of inequality varied considerably and, my impression is, much more frequently than in the hospital cases of Tabes. Not infrequently a small pupil became large or medium-sized, and this often occurred during or after a series of fits. Frequently pupils which on the one hand were equal at one period of the disease, became unequal, while on the other hand, pupils which were unequal might become nearly equal.

nystagmus. In eleven cases there was permanent ocular paralysis, four partial of 3rd, one of 4th, five of 6th, one ophthalmoplegia interna and externa bilateralis.

Among the asylum cases, paralysis of the ocular muscles was much less frequently met with. In only eight was double vision described as an early symptom (13.3 per cent). In three cases transitory diplopia occurred while the patient was in the asylum. Permanent ocular paralysis occurred in four cases, two unilateral ptosis, and two unilateral 6th nerve paralysis.

Atrophy of the optic nerve is one of the most serious symptoms that can arise in tabes; it is an early, indeed a very early symptom, and the defect of vision or blindness may be the first cause of the patient seeking advice; its frequency is difficult to ascertain. Sir William Gowers states that one in ten cases suffers with it; according to Leimbach it may be the first symptom in 1.5 per cent. Among my sixty-five hospital and infirmary cases, there were twenty with optic atrophy and ten of them were completely blind. A great many of them remained in the preataxic stage many years (vide Cases 1, 61); others became general paralytics and died. The large number of these cases was due to the fact that a considerable number were sent to me from Ophthalmic Hospitals. Again, if we took infirmary cases it would hardly be fair, because blindness leads to incapacity to earn a livelihood. When, however, we come to consider asylum cases we find that it is extremely common in tabo-paralysis; owing, however to the difficulty in examining these patients ophthalmoscopically a few cases may be overlooked, but 35 per cent. of the sixty cases were found to have well marked optic atrophy, and 50 per cent. would probably be nearer the mark, for I have found often, post mortem, optic atrophy which was not noted during life. In 150 consecutive cases of general paralysis found on the post-mortem table at Claybury, the optic nerves were carefully examined, and naked eye atrophy was found in only 7 per cent.; several of these belonged to the juvenile form of general paralysis (in which it may occur independently of any degeneration in the posterior columns of the spinal cord), the remainder belonged to the tabetic form of the

disease in adults, as ascertained by microscopical examination of the spinal cord. Optic atrophy, then, occurring in tabes is to my mind, apart from the blindness, a serious indication of the possibility of the degenerative process attacking the brain. My experience would lead me to believe that the mental worry occasioned by the blindness in a few instances tended to bring this about. The failure of vision usually commences with limitation of the peripheral field of vision in one eye and loss of colour vision; then the other is affected, or both may be affected simultaneously. The onset is usually gradual and the course slowly progressive, but sometimes the sight is lost, apparently in a few days, or almost suddenly. Doubtless in some of these cases there has been loss of the peripheral field of vision with the retention of central acuity, and it is the comparatively sudden destruction of the remaining fibres to the macula which leads the patient to believe he has suddenly lost his sight. It may, however, be (as Gowers suggests) due in such cases to an interstitial inflammatory process, but ophthalmoscopic examination shows no change to account for it.

Dr. Wiglesworth was one of the first in this country to call attention to optic nerve atrophy preceding the mental symptoms of general paralysis of the insane. In conjunction with Mr. Bickerton, he described the optic nerve changes met with in a series of sixty-six cases of general paralysis. They showed that while in the majority of cases of this disease the fundus oculi presented a normal appearance, in a considerable minority changes in the direction of neuritis or atrophy were found.

The credit of first describing the form of tabes known as optic tabes is due to Benedikt, who stated in 1881 that the abortive cases of tabes (formes frustes) are the ones in which optic atrophy is a prodromal symptom.

In 1887 Benedikt stated a law, from which he knew no exception, that the tabetic motor symptoms, no matter what development they may have reached, vanish as soon as optic atrophy appears. Dejerine points out that this latter statement is not true and I certainly agree with him, vide (among many others Case 28.) I would go further and say that

it has no influence upon the ataxy, when it arises in a patient already in the second stage of ataxy; in this respect it agrees with the fact that cortical degeneration occurring in an advanced case of tabes with well marked ataxy does not cause the disappearance of the ataxy, although the advent of dementia and other signs of cortical degeneration like optic tabes certainly arrests the spinal degenerative process and modifies ataxy of the first degree. An explanation of these facts is attempted in the chapter on "Inco-ordination." Dejerine states that the number of cases of tabes with blindness in which the disease does not progress beyond the pre-ataxic stage is considerable. He and Martin studied 100 tabetic cases at Bicêtre, eighteen of whom were completely blind, and none of these presented motor disturbance. According to my experience lightning pains usually precede optic atrophy, but not invariably. Usually when the optic atrophy occurs early, the lightning pains diminish in intensity, and even at times disappear.

An important point to remember is the frequency with which optic atrophy is followed by tabo-paralysis; in quite 50 per cent. of the cases of this form of the disease met with in asylums (and they are fairly numerous), the cerebral symptoms followed optic atrophy and blindness. In many instances the mental trouble occasioned by the blindness and loss of livelihood undoubtedly acted as the exciting cause of the brain degeneration.

Patients with paralytic dementia on the one hand, do not as a rule suffer with visual hallucinations, except in the acute maniacal condition, especially that accompanied by alcoholism. Cases of tabo-paralysis, on the other hand, with optic atrophy frequently have visual hallucinations (vide p. 79.)

Sir William Gowers states that Charcot believed that nearly all cases of so-called simple primary optic atrophy develop finally spinal symptoms, and he reports a case in which amaurosis lasted twenty years before any other symptom of tabes was noted; in another case sixteen years passed before distinct signs of tabes occurred. Every case of optic tabo-paralysis that I have examined post mortem, although many of them showed no ataxy during life, yet

presented upon microscopical examination well marked degeneration of the posterior columns due to degeneration of the exogenous system of fibres, and corresponding atrophy of the posterior roots (vide Cases 61-63).

SECTION II.

SENSORY DISTURBANCES.

Sensory disturbances are either subjective or objective, and these again are of two types: (1) destructive, causing loss of function; (2) irritative, causing abnormal or perverted The sensory disturbances relate to common sensibility of the skin, viz.: thermal condition, pain and pressure, or to the special senses, especially the complex of sensations termed "kinæsthesis" or muscular sense of Bell. The clinical phenomena of tabes, and, in a measure, of tabo-paralysis, are due to these disturbances. Although there is a symptomatic similarity among all the cases by the more or less constant presence in some stage of the disease of certain sensory disturbances, e.g., lightning pains, anæsthesia or analgesia, which are the best examples of the two types, there is hardly ever identity of symptoms, and no two cases are exactly alike. The complexity of the symptomatology agrees with the polymorphic character of the lesions. A study of the microscopic changes in the peripheral and central nervous systems in a large number of these cases explains this general uniformity and special diversity of the symptoms. The fact that changes always occur in the posterior spinal roots and their projections in the cord explains the general uniformity in the objective and subjective sensory disturbances of the skin, muscles, and joint structures, whilst the variability of distribution and extent of the morbid process in thirty-two posterior roots, and their projections in the cord, as well as the variable degree of complication by lesions of the peripheral afferent nerves, explains the frequent diversity of precise distribution of the anæsthesia, analgesia, hyperæsthesia, hyperalgesia

met with. The sensory dissociation shows that certain fibres subserving special functions are particularly affected, e.g., the muscular sense-fibres of the lower limbs, and the nerve-fibres innervating joint structures; again the light tactile anæsthesia of the mid-thoracic region, without analgesia, shows that the disease process is selective, and is related to the intraspinal terminations of the roots and not the peripheral nerves. For, in a neuritis, the sensory symptoms have not this dissociation, nor this distribution. The existence of these sensory disturbances in the insane tabetic, helps to explain many of their delusions and illusions, e.g., the idea that enemies are torturing them with electricity (it was hot irons and pincers before electricity was in general use).

The subjective disturbances of the nerves of special sense and of the viscera are still more liable to receive an insane interpretation, and give rise to delusions and illusions. There is a definite relationship between the degree of ataxy and the reflex spinal tonus, which is due to partial or complete abolition of the intraspinal paths conducting afferent impressions from the muscles, tendons, and structures around and within the joints, and this is due not only to the withdrawal of the guiding sensations, but also to muscular hypotonus.

The skin sensibility was tested in forty-eight successive cases of tabes and a number of cases of tabo-paralysis, and mapped out on charts; the distribution was subsequently, when the series was completed, compared with the root distribution given by Seiffer, which is based upon an analysis of the researches of Head, Thorburn, Kocher, Starr, and Wichmann. From thirty-two cases where root distribution was sufficiently definitely determined as regards tactile anæsthesia, a composite chart was made.

METHOD OF EXAMINATION.

Anæsthesia to light tactile sensations was made by touching the patient very lightly with the tip of the finger, analgesia by pricking with a needle, and heat or cold by a

test-tube filled with ice or hot water. The patient's eyes were covered with a towel. Twelve of these cases were carefully noted by my clinical clerk, Mr. J. P. Candler, who embodied the results in a thesis. Most of these, however, I myself have verified. The distribution and character of the sensory disturbances, when combined with a careful examination of the spinal cord and roots, will help to throw some light upon the conduction of various sensations in the cord, the functions of various tracts and groups of fibres, also the inflow of visceral sensations by the white rami. The spinal cords which I have systematically examined so far have been mostly obtained from the cases of taboparalysis or cases of tabes in which the sensory disturbances were not accurately determined during life, owing either to mental disturbances, or to the fact that they died before I commenced these researches of the accurate distribution of the sensory disturbances. Before passing to a description of my own observations, I will give a brief description of the results of other observers.

Duchenne, "Traité d'électrilization localizée," 1872, devotes a few lines to the sensory manifestations of tabes. He mentions that in the second period of the disease abolition of tactile and painful sensibility occurs. The sensibility of the feet and hands is in general more or less diminished, especially the palmar and plantar surfaces following the appearance of troubles of coordination of movement. In the skin the painful and tactile sensibility are simultaneously damaged, but more often painful sensibility is intact or little altered, and temperature is last affected. Duchenne, therefore, noted the sensory dissociation, although he was incorrect in several other ways.

Topinard, "De l'ataxie locomotrice," 1864, also Cruvielhier had noticed this sensory dissociation.

A most valuable paper has recently appeared by Förster and Fränkel.¹ These authors give an admirable summary of the work of previous observers before describing their own observations. They point out that Oulmont in Charcot's Clinique was the first to show that the statement of Duchenne regarding the fact that the objective disturbances were most constant in the extremities,

^{1&}quot; Untersuchungen über die Störungen der Sensibilität bei der Tabes dorsalis" von Dr. Frünkel und Dr. Foerster. Archiv f. Psychiatrie und Nervenkrank. Band 33, Heft 1.

was incorrect. Oulmont examined twenty tabetic women and found sixteen cases of trunk disturbances of sensibility. These disturbances were especially localised between the nipple and umbilicus and characterised by their symmetry.

The essential subjective phenomenon is girdle-sensation, and below the girdle of anæsthesia (at least in front) is a zone of hyperæsthesia.

Hitzig first emphasised the great frequency, and above all the diagnostic importance, of these sensory disturbances of the trunk.

Lähr, whose researches include sixty tabetic cases, found sensory disturbances of the trunk fifty-five times. The five cases where these sensory disturbances were absent were five taboparalytics, with only slight but nevertheless distinct spinal symptoms.

Summary of Lähr's results:

- (1) Hyperæsthesia appears to be a regular and generally early sensory disturbance of tabes.
- (2) The sensory disturbances for a long time consist only of a diminished sensibility for light tactile impressions, whilst, as a rule, in the legs there is at the commencement only a diminution of painful sensations and of the sense of position. The latter generally appears to precede the trunk hyperæsthesia.
- (3) The localisation in the trunk usually corresponds to the distribution of the middle or lower dorsal nerves. Their further distribution follows generally pretty symmetrically the encircling horizontal zone of the trunk, which extends upwards and downwards and in a characteristic manner, to the arms. In sixteen cases it spread to the arms, first to the axilla, then to the ulnar side of the arm and lastly to the radial.
- (4) The extent of this tactile anæsthesia is quite characteristic, it corresponds not to the area of distribution of the peripheral, but to that of spinal roots and their intra-medullary projection fibres. It is not, however, contended that the peripheral nerves may not be affected.
- (5) A wide-spread hyperalgesia, especially for cold, occurs in the borders of the hyperæsthetic or anæsthetic areas and between the zones affected; and the reflex excitability of the skin is here very lively. In the hyperæsthetic and anæsthetic area it may be lowered or lost.
- (6) Sensory irritation phenomena are very common, but not a regular accompaniment of the anæsthesia. Ulnar compression causing no tenderness appears as a rule in tabes in conjunction with other demonstrable sensory disturbances.

This admirable piece of work by Lähr was an important addition to our knowledge of the sensory disturbances of the trunk and especially to the localisation of the sensory disturbances in the upper extremity. Lähr also pointed out the existence of perfectly normal areas of sensibility lying between hyperæsthetic or anæsthetic areas.

Chipault's researches on the topography of sensory disturbances in fourteen cases of tabes showed similar results to those of Lähr.

These areas according to Chipault are especially the seat of sensory anomalies, the trunk, the arms, the legs. In more than one-third of his cases there was a continuous sensory disturbance of arms, trunk and legs, which is in opposition to the results of Lähr, Förster and Fränkel.

Probably his series included a large proportion of cases in the third paralytic stage. He lays stress on the coincidence of the subjective phenomena, pains and paræsthesia, with the objective demonstrable anæsthesia and analgesia of the several areas.

Patrick made observations especially upon the trunk-anæsthesia, and he called attention to the fact that in the trunk there occurs almost always only pure tactile anæsthesia, which is consequently regarded by him as a special sensory disturbance. He also pointed out that unaffected areas lie between affected ones.

Hintze described trunk anæsthesia in six out of seven cases.
Marinesco examined fifty cases in the cliniques of Raymond,
Marie, and his own at Bucharest with the following results.
There are four principal regions in which there are light tactile
disturbances of sensibility.

- (1) Thoracic.—Forty out of fifty cases.
- (2) Genito-perineal.—Under side of scrotum and later the whole scrotal regions, in well marked cases, also the penis. Less frequent in the region of the anus.
 - (3) Region of the upper limb, ulnar side.
 - (4) Region of the lower limb.

It is difficult to estimate a precise type for the lower limbs, for here are the greatest variations. Four regions correspond to well-pronounced sensory subjective disturbances: anæsthesia of the thorax to the girdle sensations: genito-perineal to impotence and rectal crises; anæsthesia on the inner surface of the arm to the ulnar sensation; lastly, anæsthesia of the lower extremities to the lightning pains, and paræsthesia.

Förster and Fränkel. These authors give a brief description with charts of fifty cases especially relating to sensory disturbances of the skin, joints and muscles. Their conclusions are as follows:

- (1) No single case of tabes with ataxy in which the sense of position of joint was not affected. The authors speak of it as joint sensibility.
- (2) Generally speaking, there is a parallelism between the sensory disturbance and the ataxy, but individual differences may exist according as the cerebrum reacts to the imperfect sensory stimuli. The degree of ataxy may not be the same in the two limbs, and the joint sensibility will then be more impaired on the side most ataxic.
- (3) As a rule, the disturbances are most marked in the joints of the toes and ankles; but sometimes they may be more marked in the joints of the hips and knee.
- (4) They call attention to the great frequency of the joint sensory disturbances in the upper limb, generally not marked, and much less (usually) than in the lower. When the case is one of arm tabes, shoulder, elbow, and wrist are affected; otherwise only the fingers (twenty-three times out of thirty-two tested cases).
 - (5) They determined the loss of sense of fatigue in five cases.
- (6) Skin Sensibility. In not one of the forty-nine cases studied could the skin sensibility be considered normal. In all but five of thirty-eight cases in which there was light tactile sensory disturbance, there was also present disturbance of painful sensibility. In the remainder there was a disturbance of painful sensibility.

Topography of disturbances of skin sensibility:

Sensory disturbances were found in the face in six cases arising at all stages of the disease. In one case, the one half of the tongue and the mucous membrane of the mouth on one side.

Sensory disturbances of the trunk occurred in forty-five cases out of forty-nine; in one case the patient was in the pre-ataxic stage. The anæsthesia generally begins above the axilla and extends forwards through the nipple to the middle line. The upper and lower borders are horizontal, uniform lines, but considerable deviations from this, the usual form, may exist, there being occasionally only islands of anæsthesia or hyperæsthesia. Out of thirty-eight cases in which light tactile disturbances were discovered, in only eight was analgesia or blunting of painful sensation found. Loss of painful sensation of trunk is later than light tactile sensibility, and in only a single case did they find the area of painful sensation more extensive than that of tactile. In four cases the anæsthetic area was hyperanalgesic. Very frequently there was an increase in the sensory excitability in the

neighbourhood of the anæsthesia. Hyperæsthesia of the trunk for cold was frequently present, also sensory disturbances of the upper extremity.

In thirty-seven cases out of forty-nine the arms were affected. The anæsthesia was continuous with the trunk anæsthesia, and extended as a streak along the inner side of the arm, limited sometimes to the upper arm and often extended to the fore-arm, and not infrequently to the inner side of the ring finger and the whole of the little finger. It may extend to the whole fingers, but very rarely affects the whole arm. The sensory disturbance is usually anæsthesia or hyperæsthesia.

Sensory disturbances of the lower extremity:-

In forty-four out of forty-nine cases there were disturbances of sensibility in the lower extremity; in eighteen of these, disturbances round the anus. In all cases the sensory disturbance was analgesia or hypalgesia, and if tactile disturbance was present, it was usually less extensive than the analgesic area, thus contrasting with the sensory disturbance met with in the trunk and upper extremities. Disturbances of heat and cold sensations are rare.

Having thus given a brief account of previous observations, I will now proceed to give the results obtained in my own cases.

Subjective Sensory Phenomena of Tabes and Tabo-Paralysis.

Lancinating Pains.—The pains of tabes are variable in intensity, situation and duration. The patient usually has suffered months or years before their true nature is discovered. They may be slight or severe, generally occurring in paroxysms, and are likened to stabbing, shooting, boring, or lightning, or to hot wires thrust into the flesh. A patient may be free from pains for hours, days, weeks, or even longer; they may last a few minutes and then cease, to recur again in the same situation or in another. attacks of pain may last a day, a day and night, or several days, causing the patient the greatest suffering and agony, relief being obtained only by morphia. Rarely does the pain correspond with the distribution of the nerve, although a patient may come thinking he is suffering with sciatica. The seat of the pain is most varied. It may start in the

great toe, and the patient thinks he has gout; it may start in joints and be attributed to rheumatism; or it may be felt in the skin or muscles. The skin is usually hyperæsthetic over the seat of the pain, whether it be superficial or deep, and this hyperæsthesia may last after the pains have ceased. Herpetic eruptions follow in very rare instances, for I have only met with one case in sixty, and that subsequently turned out to be a tabo-paralytic. In one case of taboparalysis symmetrical bullæ occurred in the limb and trunk. Examination of the peripheral nerves showed acute degeneration of the fibres, proceeding to the skin area of the bullæ. Also acute degeneration changes in the cells of the corresponding spinal ganglia. In another patient erythematous patches occurred after an attack of pain in the arms. Some patients complain of pain running in the long direction of the limbs, which they mistake for sciatica. When pain occurs in the trunk it is frequently unilateral, and not uncommonly accompanied by gastric crises. pain is frequently experienced, and a tightness compared to an iron jacket or the constriction of a tight belt has been complained of. The pain running down the inner side of the left arm might be mistaken for angina. Very often the pains radiate all over the body, and quite a number of patients who suffered with gastric crises said that with the attacks of vomiting, pains started from the mid-thoracic region and radiated all over the body with the exception of the face. One man pointed out that the face was unaffected, except in an area which corresponded to the distribution of the second cervical root (vide fig. 1, p. 47); another, a woman (Case 17), suffered so severely that she could hardly bear the touch of the bed-clothes, and even the light of the windows was so painful she would bury her face in the pillow; the only part of the body where she did not suffer the severe pains during these crises was the left leg below the knee. The right leg had been amputated above the knee for Charcot's joint. The left leg, in which the pains did not radiate, was absolutely analgesic and anæsthetic below the knee. This would rather indicate that the sentient gray matter subserving painful sensation for this leg or the intraspinal terminals of the posterior spinal neurones had been completely destroyed, therefore painful sensation could not be projected outwards into the limb. That this is a more likely explanation than destruction of the peripheral nerves is shown by the fact that pain of central origin may be referred to a limb which has been amputated.

Another case was interesting as showing that a toxic condition of the blood may set up crises and attacks. This patient (Case 20) had a discharging sinus from a suppurating Charcot's joint; she volunteered the statement that when pus accumulated owing to the sinus getting blocked, she was pretty sure to have an attack of vomiting associated with severe pain.

In the tabo-paralytics or tabetics with mental symptoms these attacks of pain may be insanely interpreted. are, therefore, rather illusions than delusions. patients often believe they are being tortured by unseen agencies, that electricity has been turned on by their enemies; they have been given poison which has gone into their legs and feet (as Case 66). They may associate the pains experienced with dreams or visual hallucinations; and they may tell you (as in two cases) that lions and wolves came and gnawed their limbs by night, and will beg you not to let them be tortured again. The pains may last during the whole course of the disease, but frequently in the third stage of the disease, when the roots which are undergoing degeneration have become completely destroyed, the pains abate or cease; that is if the disease does not steadily spread up to affect the arms. In tabo-paralysis dementia is usually associated with abolition of the painful sensations caused by pricking, and the patient as a rule does not complain of attacks of pain or torture; in this respect, markedly differing from the tabetic with delusional insanity, who probably suffers more than the sane tabetic, as he is not only tortured with physical pain, but also with delusions of persecution by unseen agencies—the true pains forming a realistic basis to the delusions around which his whole psychical existence may centre. Nearly all my cases of tabes with mental symptoms (twelve in number) were the subjects of inherited insanity, and we may consider these cases as tabes occurring in persons potentially insane—the organic disease, with its complex symptoms, being sufficient to act as a determining factor of insanity.

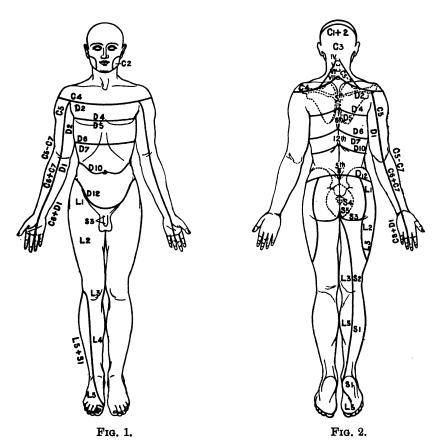
Paræsthesia.

Subjective sensations of various kinds, as numbness, pins and needles, formication, a cold trickling feeling in the skin, a feeling in the soles of the feet of walking on putty, wool, or velvet may be complained of. In rare cases Hutchinson's mask, due to affection of the fifth, occurs. The patient says his face feels stiff, and he feels as if it were covered with a cobweb. Paræsthesia of the arms, like the pains, affects the post axial border of the limb, the distribution of the (eighth) cervical and first and second dorsal roots. Consequently patients often complain of numbness and tingling in the ring or little fingers (vide figs. 1 and 2, p. 47). The insane tabetic may put a false interpretation upon these abnormal subjective sensations, e.g.: Case 31 said mice were running over her in bed at night, and she saw them on the pillow. Another used to get up at night and brush the flies out of his bed. Another (Case 27) had a feeling of cold water running up his back and over his head as far as the forehead, but not on to his face. The subjective sensation he insanely associated with the medicine he had had given to him from the London Hospital, which he asserted took the course in his system of this subjective sensation. It was of interest to learn from this patient that he had been warned by another patient that if he repeated this statement before the magistrate he would be sent away to the asylum. "But he had to speak the truth"—so convinced was he that the medicine was the cause of his trouble.

OBJECTIVE SENSORY DISTURBANCES.

Forty-eight successive cases of tabes were carefully tested for cutaneous sensory disturbances. In forty-two cases, objective cutaneous sensory disturbances were found; the six cases in which no cutaneous disturbances were discovered

were all in the pre-ataxic stage. Several of these pre-ataxic patients had had, however, subjective sensory disturbances. There were two other cases in the pre-ataxic stage in which gastric crises were associated with light tactile sensory disturbances of the mid-thoracic region and no sensory disturbance elsewhere. Trunk anæsthesia to light tactile impressions is the earliest and most constant sensory disturbance. In thirty-six cases there was anæsthesia of the trunk to light tactile sensation, and of these thirty-six twelve suffered with gastric crises. No patient suffered with gastric crises that did not develop sensory trunk anæsthesia. In most cases the affection was bilateral and symmetrical or nearly symmetrical, both upper and lower borders forming a sharp horizontal line which corresponded to the zones of distribution of the roots shown in the accompanying diagrams, Figs. 1 and 2. In this zone of anæsthesia to light tactile impressions, there may be a zone of analgesia or hypalgesia, or scattered points of blunted painful sensation. The area of anæsthesia or hypæsthesia of the trunk was usually more considerable than the analgesia or hypalgesia. The zone of hypæsthesia or anæsthesia is occasionally only unilateral, or it may be asymmetrical extending over more segments on one side than the other. There may be one or several segments anæsthetic, the most frequent being the fourth and fifth. Sometimes a segment above or below is hypæsthetic. In two cases the area supplied by a dorsal branch or branches of the posterior root was unaffected, while the area supplied by the anterior was anæsthetic. In one instance (Case 16) the patient was anæsthetic only over an area supplied by the posterior divisions of the fourth and fifth roots of the right side; then after an attack of severe pains in this region accompanied by bilious vomiting, the area supplied by the anterior divisions became affected and eventually a complete girdle of anæsthesia was found to exist. The trunk anæsthesia is most frequently met with in the fourth and fifth segments; it may extend up the chest to the third or the second interspace, and then the inner side of the arm also becomes affected. This may extend to the whole inner side of the arm, or only the inner side of the upper arm and forearm. In advanced cases, or cases commencing in the arms, there may be light tactile anæsthesia continuous with the thoracic anæsthesia affecting the whole inner half of the arm, and corresponding to the distribution of the second dorsal, first dorsal, eighth cervical and seventh cervical—that is, the whole post-axial border of the limb. It does not extend beyond the second intercostal space on the trunk,



Distribution of posterior roots to the skin, after Seiffer.

because it is very seldom that the upper cervical roots which enter into the formation of the cervical plexus are affected. In one very advanced case of tabes the whole of the skin distribution of the brachial plexus was anæsthetic. In this case (17) there was continuous anæsthesia from the fifth cervical to the fifth sacral, inclusive. In four cases the

cutaneous anæsthesia of arms, trunk and legs was continuous. In twelve cases the arms were affected, but only three times did the anæsthesia extend to the radial side of the median Whilst a considerable number of the tabo-paralytics showed subjective sensory phenomena at some period of the disease, in only some cases (31, 45, 46) could objective phenomena be demonstrated; indeed the appearance of the mental symptoms not only diminished the ataxy, but the anæsthesia and analgesia as well. In a few cases (36-44) this fact could apparently be proved. One reason why more ataxy and more marked objective sensory disturbances are not met with in these tabo-paralytic cases may be that a great many of them are in the pre-ataxic stage, and, owing to the progressive brain affection, they become so demented that they cannot be satisfactorily tested, or they die before a sufficient number of root-fibres to produce such objective phenomena are destroyed.

But how can we explain those cases where sensory disturbances have undoubtedly disappeared? Have new channels been opened up, or is there a dynamic change in the cortex cerebri concerned with the perception of tactile impressions?

In thirty-three cases the legs were analgesic or hypalgesic. There was usually complete insensibility to the prick of a needle, or the feeling only of something touching below the knee in all cases of tabes of the third stage, and often also in the later portions of the second stage. In a great many instances this analgesia was accompanied by light tactile This anæsthesia was often associated with anæsthesia. genital, perineal, and anal anæsthesia indicating involvement of the lower four sacral roots, whereas the parts below the knee indicate lumbar four and five and sacral one. Analgesia or hypalgesia of the lower extremities is sometimes limited to the sole of the foot or the peroneal surface of the lower part of the leg; it may exist independently of trunk anæsthesia and be the sole objective evidence of sensory disturbance. A patient may previously show no cutaneous disturbance and then anæsthesia or analgesia develops after several attacks of pain.

Analgesia in tabo-paralytics is fairly common, no response may be elicited from the sharp pricking of a pin all over the body (Case 55); or the patient may exhibit a cutaneous sensory disturbance of two-fold origin, e.g. Case 45, where there existed a hemi-anæsthetic condition of the limbs on the left side in which there was hemianopsy, and successive epileptiform seizures, leaving the other right half of the body free, with the exception of some analgesia below the knee, which shows the spinal origin of the latter and the cerebral origin of the former. This condition was confirmed by the fact that the right hemisphere weighed 100 grammes less than the left, also by the microscopical examination of the cerebral cortex. In other cases after unilateral seizures there was a partial hemi-analgesia and hemi-anæsthesia, with or without hemiparesis.

Anæsthesia and analgesia were discovered in 42 per cent. of the asylum cases of tabes and tabo-paralysis; probably this was much less than the reality, for in a good number it could not be ascertained owing to the mental symptoms. Still some cases of ataxy, in which definite information showed that the patients had suffered with pronounced sensory disturbances and inco-ordination before the mental symptoms came on, not only lost the inco-ordination of movement, but also the sensory disturbances, after being admitted to the asylum. It may also be mentioned that the loss of painful sensation and the retention of tactile was, as a rule, more frequently met with, and often possessed no special distribution, but affected one half or the whole body.

In thirty-two cases the charts illustrating cutaneous disturbances in the form of anæsthesia corresponded fairly accurately with the distribution of definite posterior root areas in accordance with figs. 1 and 2, and the accompanying diagrams (figs. 3 and 4) were constructed from them.

Hyperasthesia and hyperalgesia.—An area in which pains have been experienced, whether on the trunk or limbs, may be hyperæsthetic, and precede anæsthesia or analgesia; it indicates the irritation prior to destruction of the root-fibres or their intraspinal terminals. Very frequently an

area may be hyperæsthetic above or below a complete anæsthetic or analgesic area. A zone of hyperæsthesia is therefore frequently met with above the third or fourth thoracic interspace, or below the seventh or eighth. Again, there may be a patch of hyperæsthesia situated within an anæsthetic area; or on one side of the trunk, or in one limb, there may be hyperæsthesia or hyperalgesia, while corresponding parts, or nearly corresponding parts, of skin on the other side

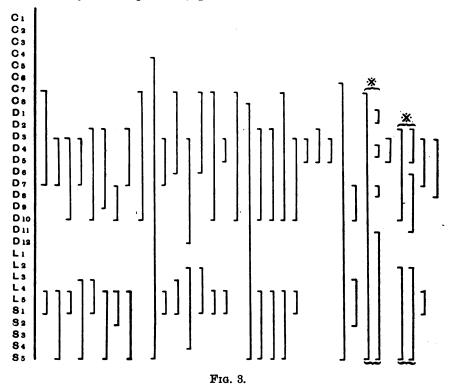


Diagram illustrating, approximately, the distribution of cutaneous anæsthesia in the posterior root areas of thirty-two cases of tabes and taboparalysis. Two cases showed unequal affection of the two sides. This diagram shows the regions least affected are the upper cervical, lower dorsal and upper lumbar.

may be anæsthetic. Systematic microscopic examination of the spinal cords and their roots serves to explain these facts. Thus I found in pretty advanced cases of tabes a more complete degenerative fibre-atrophy in the lumbosacral and mid-dorsal regions than in the remaining segments of the cord. Except in arm tabes, the degeneration of the roots ceased about the eighth or seventh cervical segments. This explains also the fact of the distribution of the anæsthesia shown in the diagram (figs. 3 and 4). Again, on one side we may have roots completely destroyed, while corresponding roots on the other side are only partially destroyed or little affected. The unequal affection of roots will not only account for cases where there is asymmetrical distribution of anæsthesia and anal-

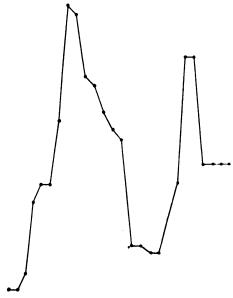


Fig. 4.

This curve is constructed from the previous diagram. The summit of the first elevation corresponds with the fourth dorsal, the summit of the second elevation with the fifth lumbar and first sacral. It is possible that each of these elevations denoting tendency to degeneration of intramedullary portions of posterior roots may be dependent upon some morphological condition, the most likely being a precarious vascular supply; indeed, this is not improbable, for these regions of the cord depend more upon small and variant arteries for their blood supply than the cervical, lower dorsal, and upper lumbar regions.

gesia, but also for hyperæsthetic zones on one side, with anæsthetic on the other; likewise, a widespread distribution of anæsthesia and analgesia, in the midst of which are islands of varying size which are still sensitive to light, tactile sensation, or pricking of pin, may be accounted for by the fact that some of the posterior spinal neurones, with their spinal projections and intraspinal terminals,

are still intact. As the diagram shows, and as the charts in fairly advanced cases (pp. 108-113) of tabes show, there is usually a gap in the regional distribution of anæsthesis over the abdomen and thighs; these skin areas are supplied by the lower dorsal and upper one or two lumbar roots, and it is these roots which microscopic examination show to be less affected. Now this region is usually sensitive to pain and touch, and, indeed, may be hypersensitive. In one case (14) where the skin was hypersensitive on the right side, deep inspiration and even movement caused severe pain, and the patient was thought to have pleurisy. The epigastric reflex was brisk on that side, whereas on the left side, where the skin of the abdomen was analgesic and anæsthetic, the epigastric reflex was absent; the cross reflex was, however, obtained.

Superficial reflexes.—The superficial reflexes, as the previous statement indicates, were directly correlated with the skin sensibility, consequently the epigastric reflexes (excepting in very advanced cases) were generally obtained. The plantar reflexes were generally diminished or abolished; the cremasteric and gluteal reflexes were more often present than the plantar, because, as we have seen, the plantar surface next to the mid-thoracic region is the most likely to have sensibility defective or abolished.

Thermo-anæsthesia.—This was not met with nearly as often as affections of light tactile sensations. Regions which were insensitive to pricking or touching with the tip of the finger appreciated heat and cold; but very frequently the tube containing hot water could not be distinguished from that containing ice-cold water, and in advanced cases both were said to have caused a pricking or burning sensation. One tabo-paralytic, after once being tested with the cold tube, refused to touch it again, as he said it burnt him. Over the abdomen in the hyperæsthetic area, patients were generally hypersensitive to cold. Delay in response was frequent in all forms of sensory disturbance. This was generally in proportion to the intensity and extent of the anæsthesia. In advanced cases also, if the patient felt the stimulus, it was wrongly localised. Occasionally there was

allochiria; in one case, for example, the sensation was referred to the other limb, and in a few instances to a point of the skin above the next joint higher up in the limb. A stimulus which was not at first felt would subsequently provoke a response by repeating it a few times, thus illustrating the effect of summation until the neurone threshold is crossed by the impulse.

Ulnar sensation of Biernatsky was tested in many cases, and it was found that compression of the ulnar nerve at the elbow produced no tingling or pins and needles in the fingers; but in many normal people one cannot sufficiently compress the nerve to produce pain.

Insensibility to pressure of Testicles.—In some cases pressure of the testicles was tried, and it was found that pain was not produced; but this sign, which is undoubtedly a useful one, was not systematically adopted. Sometimes impotence may be associated with this sign.

Vibration of Tuning-fork on Bone.—Dejerine has pointed out that a tuning-fork placed on the bone causes no sensation of its vibration in tabetic patients, indicating a break in the path of conduction of the sensory impulse from bone. This sign was tried in some of the cases which later came under observation, and always verified in patients who were in the second or third stage of the disease (Case 22). Several cases in the pre-ataxic stage did not yield the sign, but I have ascertained in one case that diminished sensibility may exist very early, and be unequal in the two legs.

VISCERAL DISTURBANCES.

Bladder troubles are among the earliest and most constant symptoms of tabes; they are not severe, and in my experience the patient does not frequently seek advice for this reason. Comparatively few of the cases that came to the hospital sought relief especially for bladder troubles; it is only as the result of inquiry, as a rule, that the patient, in relating his symptoms, mentions difficulties in starting micturition or holding his water. When asked if he has noticed any difficulty with his water, the patient will tell you either that he has a difficulty in starting the stream,

requiring a strong voluntary effort on his part, or that it lacks force, and takes him time to empty his bladder; in the later stages he does not empty the bladder completely, consequently he frequently suffers with residual urine, and catheterisation is necessary. This condition indicates lack of power in the detrusor urinæ, whereas another frequent condition met with, indicates loss of reflex tonus in the sphincter; for a cough, laughing or any cause leading to increased intraabdominal pressure, suffices to cause the escape of a little urine into the urethra, followed by the urgent desire to micturate.

Bladder crises have been described, but they are rare. I have not met with a case. They consist of violent pains which occur in the lower part of the belly radiating to the urethra, and the inner side of the thigh. The patients have an urgent desire to micturate, but are unable; they experience the most severe burning and cutting pains in the urethra, and these may be associated with lancinating pains throughout the lower extremities. These crises may last a few or many hours.

In about one half of the cases which I observed there was a history of bladder troubles; this is much too few. The disparity with the results of Leimbach's analysis of Erb's patients (80 per cent. bladder disturbances) may be accounted for by the fact that in out-patient practice in London, where there are so many hospitals, many of the cases are seen only a few times.

In the tabo-paralytic cases, bladder trouble, apart from the incontinence of dementia, was only discovered in 60 per cent, probably again much too few, for examination of the spinal cords in a number of these cases showed that the lumbo-sacral segments of the cord were especially liable to the degenerative atrophy.

Renal crises have also been described. Some of these cases may doubtless be due to the passage of a stone or gravel in a patient suffering with tabes.

Gastric Crises.—In twenty-one patients out of sixty (36 per cent.) gastric crises occurred, and they were not infrequently the earliest symptom of the disease, as the attacks

of pain and vomiting were the sole cause for which the patient sought relief. In one, Case 7, the patient was admitted for intestinal obstruction, and the surgeon was sent for with a view to operation.

Recently I have seen a case in which visceral crises were very severe, and tabic symptoms so ill-defined that although the patient was seen by several distinguished physicians, the true nature of the disease was not discovered, and a surgeon was called in, who performed an abdominal section, and found all the organs normal. He had absent knee-jerks at the time; it would be interesting to know if he had not Argyll-Robertson pupils and thoracic anæsthesia, as he undoubtedly had when I saw him later. Moreover, he said that before the operation his legs had given way on occasions, and symptoms pointing to rectal crises were recounted. I am informed that the reason why the operation was performed was the existence of pus and blood in the urine on intermittent occasions, plus a large movable kidney. The symptoms seemed also to suggest pyloric disease.

In all cases, as previously stated, the crises were associated with complete or partial anæsthesia in the mid-dorsal region, and often with persistent subjective girdle sensation, but by no means every case of thoracic anæsthesia in this region was associated with gastric crises. This would show that if the crises are due to affection of afferent visceral nerves they are affected independently, and that the relative frequency and early appearance of gastric crises is due to the fact that they or their intraspinal terminations are under the same determining contributory factor to degeneration as the intraspinal terminals of the posterior roots supplying the skin of the mid-thoracic region. One intelligent patient, Case 3, remained in the pre-ataxic stage twenty years, the sole symptoms of the disease of which he was conscious being attacks of severe pain, "sharp" in character, which extended both vertically and transversely between the shoulder blades and over the whole back; as soon as the pain became acute, vomiting would take place and relief would come. He had no pains in the region of the epigastrium, the attacks of vomiting would last three or four hours.

The attacks of vomiting may be preceded by a pain or a feeling of weight at the epigastrium, in one patient the vomiting was preceded by intense occipital headache, and a feeling of distension of the stomach, and this was followed by lightning pains through the whole body, except the face and the leg which was analgesic and anæsthetic. Severe attacks may last several days, the patient vomiting the contents of the stomach, whatever they may be, and the retching continuing with short intervals, just as in sea-sickness or cerebral tumour, only mucus or watery mucus frequently mixed with bile being voided. In several severe cases, the patients have occasionally vomited coffee ground material, or blood, due probably to rupture of congested vessels. The patients suffering with severe attacks are quite unable to retain food or even water in the stomach, and the pains may be so agonising that they shriek out. The tongue is dry and furred, the lips parched with thirst; worn out with the want of sleep and the distressing symptoms, it is remarkable how soon they recover as soon as the attacks cease. Chemical analysis of the gastric secretion has given variable results, but generally the acidity is diminished.

Occasionally the patients suffered with incomplete gastric crises in which there were only paroxysms of cramp-like pain of the stomach, or only eructations and vomiting without pain.

One patient, Case 57, suffered for years with "rheumatic pains" and "indigestion," for which he was treated at several hospitals without relief. After three years he had delusions of persecution, that unseen agencies turned on electricity and blew up his stomach, and he was admitted to an asylum where his ataxia and progressive dementia were observed. Post-mortem examination of the spinal cord showed the typical tabic lesion, and there is no doubt that he suffered with modified gastric crises.

A few cases of gastric crises were occasionally accompanied with frequent purgations. I did not personally meet with any attacks of the intestinal crises which have been described as occurring occasionally; but see Case 46 of taboparalysis. They are said to be unaccompanied by pain, apparently suddenly and without cause, frequent watery evacuations of the bowels take place for days, weeks or

months, and then as suddenly cease as they appeared. Rectal crises, however, are not so rare; they were met with in 8 per cent. of the cases, and like gastric crises were among the early symptoms. The patients complain of tenesmus, and urgent desire to stool, of severe pain in the back passage like the introduction of a hot iron; sometimes this is accompanied by tenesmus and straining, and it is said evacuations of blood and slime may be passed. Some of these cases may have been institution dysentery. Much more frequently the patients suffer with constipation and difficulty of relieving the bowels without purgatives. Not infrequently they are unable to keep themselves clean. Especially is this the case when they have to start micturition by strong voluntary pressure of the abdominal muscles; fæces are then apt to escape owing to some loss of the reflex tonic contraction of the sphincter ani; moreover, they cannot always tell when defæcation is complete.

In 8 per cent. of the tabo-paralytic cases gastric crises occurred. These visceral disturbances are of great importance, and, in a few instances, seemed to account for the delusions with which the patients suffered, e.g., one patient accused the nurse of having put something chopped up in her milk, and of having scraped her bowels out. Case 31.

Laryngeal Cases.—In only two cases were laryngeal crises met with, and these occurred early in the disease. This symptom was only once (Case 27) met with in the asylum cases, and it is relatively infrequent. The symptoms may in some respects simulate an attack of whooping cough or laryngismus stridulus. One man complained of a sudden spasm of the glottis, with difficulty of breathing, which lasted a few minutes; at the time of the attack he suffered with a burning pain in the larynx and a feeling that he was going to be suffocated. By closing the mouth and breathing only through the nose the attacks were diminished in duration. The attacks are accompanied by stridulous inspiration and followed by short sharp coughs. are not so frequent as visceral crises, and months or years may intervene. The attacks are occasionally very alarming. and may be accompanied by epileptiform seizures and loss

of consciousness. These crises, together with laryngeal paralysis (usually adductor, sometimes one-sided, sometimes bilateral), are considered as evidence of affection of the vagus and spinal accessory rootlets. Sir William Gowers remarks that "in all, if not most, of these cases of adductor spasm there is permanent weakness of the adductors, which, when considerable, constitutes a very grave complication. In rare cases the spasm may proceed to the pharynx, making swallowing impossible, and in one recorded case the spasm extended to the respiratory muscles, causing asphyxia and death." Bronchial crises have been described, and in one case the onset of gastric crises was followed by disappearance of this symptom.

Retardation or irregularity of the heart's action have occurred in connection with gastric crises, and precordial pain with anginal attacks have been described (vide Case 27).

Genital Organs.—Impotence may be an early or a late symptom. It may be preceded by satyriasis. In some cases impotence is associated with anæsthesia of the external genital organs; in some it is associated with atrophy of the testicles. Diminished sexual power occurred in some of the cases, and absolute loss of sexual power in, at least, 16 per cent.; this, too, may be an early or late symptom. Increased sexual desire is pretty frequent in the early stages of general paralysis and in the tabic form of the disease.

Atrophy of the testicles is of frequent occurrence in general paralysis, and, generally speaking, the testicles lose weight out of proportion to other organs. The satyriasis in a tabo-paralytic may be associated with delusions of extraordinary sexual power; there is often marked desire, but no ability of performance of the sexual act.

Sense of Position of Joints.—The sense of position of joints was tested in thirty cases, and in seven no appreciable affection was shown. All of these seven were early cases, and the diagnosis of tabes was usually based on other evidence than ataxy, viz., Argyll-Robertson pupils, lancinating pains, optic atrophy, visceral crises, and trunk tactile anæsthesia. In all of these seven cases there was no appre-

ciable disturbance in cutaneous sensibility of the limbs. four very pronounced cases of Charcot's knee-joint, there was no loss of sense of position discovered in the toes; but one of these had impaired cutaneous sensibility to pain and touch in the legs (Cases 11, 5). There was usually a distinct correlation of loss of sense of position of the joints and the degree of ataxy, also between the disturbance of cutaneous sensibility and the joint sensibility. one case of arm tabes, there was loss of joint sensibility in the arms, especially the right, in which the disturbance of cutaneous sensibility was most marked. twenty-one out of thirty cases examined, loss of joint sensibility was found in the toes. In eleven the sense of position in the joints of the whole lower extremity was affected, but nine of these cases were in the third paralytic stage, and there was a correlated loss of sensibility to touch and pain, and in some cases also marked thermo-anæsthesia. In nine out of thirty cases the joint sensibility in the upper limb was affected, and in all cases accompanied by disturbance of cutaneous sensibility, especially of the post-axial border of the limb. In three very advanced and prolonged cases of ataxy, the joints of the whole limbs were affected; in the others it was only the fingers (especially the ring and little fingers) or the fingers and the wrist joints. In one case of fairly complete loss of joint sensation of the upper limb there was only moderate disturbance of cutaneous sensibility. The joint sensibility was lost in the hand on the right side in one case where the loss of cutaneous sensibility was most pronounced. The conclusion arrived at is that loss of sense of position in joints is a very important factor in the production of inco-ordination of movement; it is associated usually, but not necessarily, with loss or disturbance of cutaneous sensibility.

The fact that the toes and fingers are affected first, then the ankle and wrists, and later the joints above, agrees with the distribution of objective sensory disturbances. No doubt the proto-neurons, subserving cutaneous and joint sensibility, are quite independent structures; but, as a rule, they are simultaneously affected. I believe this sense of

position of joints is due to a complex of sensations arising in alterations in tension of structures about joints, rather than in the alteration of contact of surfaces such as Prof. James assumes to be the case in judging the sense of position of limbs. It may be pointed out that no one has demonstrated nerve-endings in articular cartilage; there are, however, nerve structures in the synovial membrane and capsule of the joint, in the tendons, muscles, and fibrous structures. The most important nerve-endings are undoubtedly the Pacinian corpuscles, which are especially constructed to be influenced by alterations of tension and pressure in the deeper structures. In support of this argument is the fact that arthropathies (Cases 5, 11) may occur without loss of sense of position and without ataxy, although I have not met with a case in which sense of position of the joint was lost without ataxy.

I have met with several cases of ataxy without loss of sense of position of the joints, even of the toes, and several tabo-paralytics, who were able to give reliable answers, showed the early symptoms of ataxy without loss of joint sensation.

Deep Reflexes.—In seven cases, not tabo-paralytics, nor with cerebral lesions, the knee-jerks were present on both sides. In three the knee-jerk was present on one side and absent on the other; that is to say, absent knee-jerks were found in less than 70 per cent. of my cases when first seen, but then a considerable number of the patients were in the pre-ataxic stage; in fact all the ten cases, except a case of arm tabes, were in the pre-ataxic condition, most of them suffering with optic atrophy or other ocular troubles; two came with gastric crises. In two cases the knee-jerks disappeared first on one side then on the other, after a series of attacks of lightning pains in the legs.

The triceps jerk was not observed in the earlier cases which came under my observation; but it was usually found absent when the knee-jerk was absent, although there might be no other symptoms affecting the arm. In some cases, however, it was present when the knee-jerk was absent; it undoubtedly disappears later than the knee-jerk.

Tonus.—A diminished tonus (as tested by the Fränkel method) was found in all but eight cases, in which the patients were in the pre-ataxic state. In other cases there was a distinct relationship between the degree of hypotonus and the ataxy of the limbs, and if there was a difference in the degree of ataxy of the two limbs it was observed that more marked hypotonus was present in the more ataxic limb.

In the asylum cases the knee-jerks were absent on both sides in 77 per cent., absent on one side in 16 per cent., present on both sides in 7 per cent. As a rule the hypotonus was not so marked as in the tabic cases met with in the hospitals and infirmaries, nor was the ataxy. This is possibly due to the cerebral disease withdrawing the normal inhibitory influence. With the onset of the mental symptoms, the inco-ordination of gait and station and muscular hypotonus underwent improvement, and the symptoms, in some cases, apparently so far disappeared that one was not able to prognosticate the extensive degeneration of the posterior columns which I found in many of them.

If, however, the patient has advanced well into the second stage of tabes, the onset of the mental symptoms is only accompanied by a less degree of ataxy, and the characteristic inco-ordination in gait and station in great measure persists, so that one is easily able to pick him out from a number of cases of general paralysis as a taboparalytic. As the brain becomes affected the ataxic gait often gives place to a shambling or shuffling gait, and I have been surprised what an extensive amount of degeneration of the posterior roots and posterior column of the spinal cord may be found in such cases. Very frequently (especially if the patient has had epileptiform seizures) this is combined with very extensive crossed pyramidal degeneration. So that although one was unable to obtain the knee-jerks on either side, yet, on the side of the fits and hemiparesis. Babinski's sign was obtained, vide Case 54.

In one case (44), however, the knee-jerk returned on the side upon which the fits occurred.

Romberg's symptom, so frequently a constant and

prominent symptom in ordinary tabes, may be only slightly obvious in asylum cases.

25 % tabo-paralytics, slight ataxia only discoverable by careful examination. Romberg's symptom absent.

30 %, moderate ataxia observable in gait and station. Romberg's symptom present.

15 % marked ataxia advanced second and third stage.

30 % pre-ataxic tabo-paralytics, no ataxy discoverable; diagnosis made by symptoms, lightning pains, optic atrophy and absent knee-jerks. Very frequently subsequent examination of the spinal cord by careful microscopical examination has demonstrated the correctness of the diagnosis.

Romberg's symptom was very marked in only 15 per cent. of the cases, moderately in 26 per cent. and slightly in 7 per cent.

SECTION III.

Affections of the cranial nerves are less frequently met with: it is not common to find the olfactory nerve affected in tabes, but occasionally, as my cases have shown, loss or imperfection of smell and the taste for flavours has occurred. Sometimes, as Case 10 shows, this was preceded by a curious and continuous odour in the nostril, like a drain; it is sometimes likened to rotten fish, phosphorus or sulphur, and paroxysmal attacks of this perverted olfactory sense may precede the complete loss of smell. These attacks, when they occur, are of the nature of crises and may last hours, days or weeks; it is of importance to bear this in mind in connection with the subjective attitude of an insane tabetic patient, or a tabo-paralytic, to these abnormal sensations; unable to explain their presence, he might put an insane interpretation on them, thinking that his food was poisoned, or that foul odours by unseen agencies were working upon him. Although loss of smell and the taste for flavours is uncommon in tabes, it is relatively frequent in tabo-paralysis and general paralysis, and this accords with the anatomical results found post

mortem, for the orbital surface of the brain and the tip of the temporal lobe in which it is presumed the sense of smell and taste is located, are very generally the seat of extensive atrophy and thickening of the membranes.

Sometimes the patients are said to lose sensibility of the mucous membrane of the nose, and no longer sneeze when it is irritated, or they may be subjects of paroxysmal attacks of sneezing and tickling of the nasal mucous This is due to affection of the nasal branch membrane. of the fifth nerve, and is rare. Other affections of branches of the fifth nerve are pains, anæsthesia and paræsthesia in various regions of its distribution. these disturbances of sensibility, there may be various socalled trophic disturbances, such as a rapid falling out of the teeth, and absorption of the alveolus of the jaw. Several of the cases showed this, but in some instances (Cases 2, 15, 17) it may have been due to the mercury given in the treatment of syphilis. The sensory disturbances of the fifth are sometimes manifest, and sometimes so trifling as to be unobservable; there does not appear to be any relationship of the teeth dropping out and absorption of the jaw to anæsthesia of structure supplied by the This is in accordance with what we know of joint and bone diseases, which are frequently very early symptoms, and are in no way related to the sensory disturbances of the skin; the teeth fall out without any pain being experienced.

Other rare conditions due to affection of the trigeminus have been described, namely, ophthalmia neuro-paralytica and corneal ulcer. Both corneal ulcer and tabic ulcer of the mouth are analogous to the perforating ulcer of the foot. Again, sialorrhœa, which occasionally occurs, generally in paroxysmal attacks, has been attributed to affection of the trigeminus.

Disturbances of taste, due to affection of the glossopharyngeal nerve, are very rare; cases do occur occasionally in the form known as medullary tabes (see Case 62).

Auditory nerve.—The result of affection of this nerve as in other cases may be irritative or paralytic. Paroxysmal attacks of noises in the ear like rushing water, bells or

shrill whistling sounds, or even musical sounds may occur (Cases 62, 24). This, no doubt, is due to the affection of the neurons supplying the labyrinth; but the neurons supplying the semi-circular canals may also occasionally be affected, and give rise to symptoms like Menière's disease, namely, attacks of giddiness or loss of balance. But it is difficult to determine whether this is not really due, in the absence of other signs of affection of the auditory nerve, to migrainous attacks or slight attacks of petit mal, or the giddiness of congestive attacks occurring in patients who are in the initial stage of progressive paralysis. Occasionally, as Case 62 shows, absolute deafness may occur.

DISEASES OF THE BONES AND JOINTS.

Arthropathy and bone affections occurred relatively frequently in my cases of tabes. They were met with oftener in women than men, and not infrequently were associated with gastric crises (Cases 5, 17). Spontaneous dislocation or fracture was often the cause of the patient seeking medical or surgical advice. Joint affections and spontaneous fractures were met with not only in hospital, but also asylum cases. It is of considerable importance to bear this in mind, otherwise officials and attendants might be charged unjustly with neglect or ill-treatment, when in reality a very trivial accidental injury or no real injury, merely turning the patient in bed, might be followed by spontaneous dislocation or fracture in asylum cases of tabes or tabo-paralysis. Not long since I saw a fracture of the thigh in a young man suffering with juvenile tabo-paralysis; the spinal disease was not discovered during life, but microscopical examination of the cord showed the characteristic lesion. It would have been easy to have cast blame in such a case as this, for the immediate cause of death was due to infective suppuration around the seat of fracture. Such fractures may occur apparently spontaneously or as a result of a very slight injury, or even a false step; they are usually quite painless, and one patient told me she did not know her leg was broken until she saw

the ends of the bone sticking up (Case 71). A considerable number of women in workhouse infirmaries lie there incapacitated for numbers of years with tabic joints. One of the earliest cases reported by Dr. Buzzard is still in the St. Pancras Workhouse, where she has been nearly thirty years; the gastric crises and lightning pains, from which at one time she suffered excruciating agony, have latterly almost ceased. The joint affection may, as in Case 5, be the sole symptom causing the patient any trouble; for of course the physical signs, namely, the existence of the Argyll-Robertson pupils and absent knee-jerks, would be unknown to the patient, and if there were lightning pains, they would be put down to rheumatism. There is no doubt that, as in rheumatoid arthritis, hard occupations involving much use of joints predispose to the disease. Case 5, a stonemason, in whom a large painless swelling of the right shoulder-joint was the first symptom, is an illustration, for he used this arm for his hammer. Again, a carpet-planner, who knelt all day, had an enormous painless swelling of both kneejoints. The poor women I met with in the infirmaries suffering with Charcot's knee-joints nearly always gave a history of being widows who had to earn their living by charing and scrubbing, or by using the sewing-machine. The two cases of tabic foot met with, were men who had been in the army, and subsequently worked at a forge, and were, therefore, standing all day at their occupation. In the cases which came under my notice of joint affection there was usually a history of a trivial injury such as a knock, a false step going downstairs or from the kerb, or such like. The swelling was not invariably painless, and it appeared to me sometimes difficult to differentiate some of the cases from rheumatoid arthritis occurring in a person suffering with tabes or tabo-paralysis, had not rapid effusion into the joint indicated a true tabic arthropathy.

Symptoms.—A masterly description by Charcot of the tabic arthropathies has led to the affection being named after him. He pointed out that without any sufficient cause a joint would suddenly swell up, owing to a serous exudation into it and possibly into its surrounding tissues. This

swelling is unaccompanied by either pain or fever. In the favourable form the swelling may disappear after a time, and a return to the normal condition take place, or severe destruction of the joint may occur accompanied by crepitus, wearing away of the articular surfaces and even the bone, causing dislocations and luxations. The knee is by far the most frequently affected, after this the hip, shoulder, elbow, wrists, more rarely the ankle, vertebral, and finger joints. Marie states that from 4 to 5 per cent. suffer from joint Among my cases there were 10 per cent. affections. The joints were examined in two of the cases; one was hardly characteristic, for a sinus existed with dead bone and continuous purulent discharge; the leg was amputated by Mr. Walsham, the capsule of the joint was greatly thickened and dilated, there were numerous osteophytes, and the cartilage was ulcerated but not entirely destroyed; there was an osteo-porosis of the bones; some nerves were dissected out that were proceeding to the peroneus longus muscle, and separated from the surrounding tissues away from contact with the suppurative process. A small piece was cut off and teased, the fibres were found (after suitable staining) to be undergoing an atrophic degenerative process (Case 30), but the appearances are not unlike those described by Marinesco after amputation; and seeing that the leg was extremely wasted and the joint so disorganised as to be quite useless—hence the amputation—it may be asserted the condition was an effect of the joint disease. In a case of tabetic general paralysis the knee-joints presented an appearance in some respects resembling rheumatoid arthritis both during life and post mortem. capsules and synovial membrane were thickened, contained excess of synovial fluid, and the cartilages were ulcerated (vide fig. 5). The patient was too demented to say whether it was painless or not. This was a case of very advanced tabes, and there was atrophy and degeneration of the peripheral nerves and the small nerve fasciculi of the skin.

In advanced cases the joint surfaces with the cartilages may quite disappear, and the bony structure in the joint may be destroyed and appear as eroded away. Proceeding pari passu with the atrophy there may be numbers of outgrowths in the capsule and synovial membrane. Chemical examination shows that the bones are deficient in mineral matter, especially phosphates. The Haversian canals are dilated irregularly and filled with fat. According as the process affects the epiphysis or the diaphysis an arthropathy or spontaneous fracture occurs, sometimes both (Case 71). Similar joint affections may occur in syringomyelia.

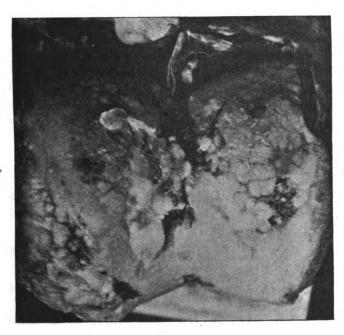


Fig. 5.

Photograph of the articular surface of the femur from a case of arthropathy in a typical tabo-paralytic female with all the clinical symptoms of the disease. Microscopic examination of the brain and spinal cord showed characteristic lesions.

A peculiar malformation arises when the joints of the tarsus are affected; on the back of the foot and in the middle of the sole there arises a hard prominence, the foot is flattened and shortened and the bones of the tarsus are, as it were, driven into one another. Crepitus is obtained on movement, but no pain produced. The ligaments of the joints may be destroyed; several such were met with

both in asylum and hospital cases. Tendinous tissue may probably undergo similar atrophic changes, for sudden painless rupture of a tendon which does not tend to heal may take place.

Whether the bone and joint disease of tabes is dependent upon a definite lesion of the nervous system is still a moot point. Charcot believed at first that it was due to a lesion of the anterior horns. Other authorities attribute it to a disease of the peripheral nerves, especially of those supplying the bones, but this condition does not occur in peripheral neuritis. The loss of bone sensibility may, however, be an early sign in tabes. I recently examined a patient who presented very little ataxy and yet there was very distinct evidence of diminished bone sensibility by Egger's test, with the vibrating tuning fork. Recently Marinesco has attributed it to anæsthesia and absence of reflex regulation of the blood supply; it may also be due to the direct action of toxins upon the nutrition of the bones.

In a large number of experiments which I made many years ago of section of anterior and posterior roots in monkeys, I never met with any change in the bone with the exception of one case in which the posterior roots of the cauda equina were ligatured on the right side so as to cause degeneration; the animal was killed three weeks later. The bones of the leg on this side were so brittle that I could snap them with my fingers. The right femur was the same size as the left, when dried the right weighed 7.5 grams, the left 12.5 grams. The right os innominatum was the same size as left, when dried the right weighed 5.5 grams, the left 7.7 grams. The tibiæ were also brittle, but were used for microscopical purposes. softening in chromic and picric acids transverse sections were cut by the freezing microtome, stained with logwood and eosin, and mounted in Farrant's solution.

There was a naked eye osteo-porosis on the right side. The periosteum was apparently normal. Examined microscopically there was a marked dilatation of the Haversian canals, and owing to the absorption of the intervening bone, coalescence had taken place with the formation of irregular

shaped channels, which contained blood-vessels surrounded by a reticulum of connective tissue in which were seen numerous osteoclasts; these large cells were disposed usually at the periphery lying in little scalloped out places which they filled and which they apparently had caused, by absorption of the osseous substance (vide photomicrograph, fig. 6).

Bayliss and Starling have shown that stimulation of the lumbo-sacral posterior roots causes dilatation of the vessels of the lower limb; therefore vaso-dilator excitation may have



Fig. 6.

Photomicrograph of section of tibia softened in a mixture of picric, nitric, and chromic acids, stained with alum hæmatoxylin and mounted in Farrant's solution.

Magnification 300 diameter.

been set up by the ligature and caused dilatation of the vessels of the lower limb including those of the bones, with consequent absorption and diminution of the mineral matter; for although, as we have seen, the bones were equal in size, there was a marked difference in the weight, and microscopically it was found that this was due to absorption of the osseous matter around the Haversian canals.

MOTOR DISTURBANCES.

The cases may be classified clinically as follows, according to their motor disturbances:

- (1) Motor disturbance slight or not discoverable. Preataxic condition, disease spinal:—Loss of deep reflexes on one side or both sides, slight hypotonus. No subjective motor trouble. Objective signs only discovered by expert examination. Other signs and symptoms lead to diagnosis.
- (2) Preataxic condition simulated, spinal combined with cerebral or optic disease:—In such cases the spinal disease may at one time have produced subjective symptoms and objective signs of ataxy, and the onset of the mental symptoms or the optic atrophy with blindness masks the same, or causes them to disappear partially or entirely. There may be loss of knee-jerks, or the knee-jerk may be lost on one side only, or it may return on one side after a series of unilateral fits. Cases 41, 44, 65 show that these patients have suffered with extensive degeneration of exogenous fibres sufficient to produce fairly marked ataxy. Most common in asylums.
- (3) Ataxy of first stage, subjective difficulty only in the dark, or with eyes shut discoverable by examination, same as (2) without mental affection:—Loss of deep reflexes, well marked loss of tonus, Romberg's symptom moderate. Considerable atrophy of posterior roots, half to one-third of fibres and their intra-spinal projections destroyed.
- (4) Ataxy of second stage, obvious ataxic gait, subjective difficulty in daylight necessitating support:—Nearly complete atrophy of the lumbo-sacral root-fibres, considerable atrophy of endogenous systems of fibres, especially descending comma, septo-marginal, oval area, and Phillippe's triangle. Case 39.
- (5) Paralytic bed-ridden stage, frequently accompanied by deformity and great muscular wasting, especially of certain groups of muscles, which may in rare instances undergo degenerative atrophy. Cases 28, 31.

The fuller consideration of the motor disturbances is discussed in the pathological section, chapter "Incoordination and its Pathology."

CEREBRAL SYMPTOMS.

I have already alluded to the frequency of optic atrophy in the cases of tabes and tabo-paralysis which have come under my observation. I will now refer to other cerebral Mental symptoms occurred in about 10 per symptoms. cent. of the cases seen outside of the asylums; some few of these were pronounced general paralytics of the tabetic type, others were tabetics with symptoms indicating early organic affection of the brain, and the remainder were cases of tabes dorsalis with associated insanity. Some of the cases seen in the hospitals and infirmaries afterwards died in one of the asylums at a near or remote period from the time I saw One case in particular, J. W., attended my outpatients for several years, affected with progressive optic atrophy, limitation of the field of vision, and early signs and symptoms of cord affection. I lost sight of him for some years, but found him suffering with advanced general paralysis in Claybury Asylum, and he died there. The same types of tabo-paralysis were met with in the asylums, the only difference as a whole between the cases was what we would expect: in the former the cord symptoms predominated, in the latter the mental symptoms. It was, however, a well-established fact that some patients who had been observed outside of asylums as cases of locomotor ataxy, after admission to the asylums, and therefore after the development of well-pronounced mental symptoms, without treatment of any kind, became less ataxic in their movements, the gait becoming altered. As in general paralysis so in tabo-paralysis, the onset of cerebral symptoms may be sudden, and due to seizures which are recognised as congestive, apoplectiform, epileptiform, and migrainous. The seizures may lead to a disturbance of consciousness, or partial or complete loss of consciousness. Thus a patient may be suffering with discovered or undiscovered objective or subjective signs and symptoms of tabes dorsalis, when suddenly, or comparatively suddenly, he is seized with some kind of fit. There may be a temporary disturbance of consciousness, a sudden feeling of giddiness, associated with frontal headache like migraine. Generally

such an attack is due to circulatory disturbances of the brain, but it is conceivable in rare cases of tabes; frequent migrainous attacks may be due to disturbances of the sensory impressions from the semi-circular canals. These attacks often escape observation, until one more severe necessitates a doctor's advice, then the true nature of the disease may be discovered by the examination of the pupils and the condition of the knee-jerks and other signs of tabes or general paralysis. This will lead to further inquiries of the patient for such early subjective symptoms as lightning pains. Often, however, the patients disregard these slight attacks, and such cases do not come under observation until more serious brain symptoms develop. Some of my cases show that a history obtained from the wife or friends may give evidence of such attacks occurring years before the patient suffers with mental symptoms severe enough to cause his admission to the asylum. Epileptiform seizures may be the first evidence of cerebral affection, and may precede or succeed spinal symptoms. Cases 36, 52, 53.

I have frequently found, by questioning the wife, that her husband, previous to his coming to the asylum or the hospital, had a fit with convulsive spasms affecting one side. He had recovered from this, and was comparatively none the worse for it. In 30 per cent. of sixty cases of taboparalysis the patient suffered with numerous epileptiform seizures. In 34 per cent, there was a history of one or more fits, but seizures did not form a prominent symptom of the disease. In the remaining 36 per cent. no fits were observed by the friends or attendants during the whole course of the disease. Epileptiform seizures in the case of well-marked tabes, where there is presumably well-marked degeneration of the posterior roots, had not been notably characterised by inco-ordination in the convulsive spasms. This is a matter of some interest and will be discussed later. The epileptiform seizures may be slight, limited to twitching of one side of the face or to a limb, or they may extend to the whole of one side of the body, or they may become bi-lateral. and the muscular spasm so severe and general as to cause opisthotonus or emprosthotonus. The convulsive seizures

in Case 46 were extremely interesting, for this man was in an advanced stage of locomotor ataxy. Loss of consciousness may be partial or complete, and there is a correlation between the severity and the extent of distribution of the muscular spasm and the depth of unconsciousness; as a rule, when the convulsions are limited to one side, the loss of consciousness is only partial; the pupil is usually larger on the opposite side to that of the seizures; the face is congested, the skin perspiring freely and its surface temperature raised from 5 to 1.5 degrees Fahr. on the affected side.

When extensive convulsions occur continuing for several days (a condition of status epilepticus), there may be high fever, even hyper-pyrexia, which may cause death. Such severe attacks, however, are associated not infrequently with the onset of an acute disease such as pneumonia and dysentery, which kills the patient; and if the bowel has not been examined, and the lungs be only in the first congested stage of pneumonia, the patient's death is attributed to the seizures; whereas really the seizures have been excited by the toxic condition of the blood, and have only accelerated The same applies to epilepsy. After the fits have ceased, the patient recovers rapidly, and his mental condition may even appear to have improved. This is not really the case; the functional disturbance of the whole brain caused by the congestion has passed off, and his mind is therefore less affected, but the result of the fits is usually tissue-destruction. In my opinion, the fits are often the expression of an increased irritability preceding decay or even death of the psycho-motor neurons of the cerebral The degeneration of the pyramidal fibres of the spinal cord is most abundant on that side on which the fits occurred, if they are unilateral; when the fits are bilateral, the degeneration is proportionately great on both sides. My observations would show that acute death of the cells is due in great measure to vascular inflammatory disturbances. but degeneration of the pyramidal fibre-systems, especially those fibres which come from the leg area, may occur independently of any fits, and, as I shall show later, are due to degenerative atrophy commencing in the collaterals and

terminal portions of the fibres, as in idiopathic lateral sclerosis and antyotrophic lateral sclerosis. In some cases the changes are obviously vascular and due to arteriosclerosis affecting the small vessels; as a rule, however, there are not sufficient gross changes in the arteries to account for the wasting of the brain. In Case 45 the right hemisphere was particularly affected, it weighed 100 grammes less than the left. Although there was such tremendous destruction of the right hemisphere and very considerable destruction of the left, the dementia was comparatively slight; so much so that the attendants did not think that he could be a general paralytic. His speech, moreover, was but slightly affected. He suffered with left-sided hemiparesis and well-marked hemi-anæsthesia and hemianopsia. The cause of this is discussed in Case 48, where there are well pronounced left sided seizures, no hemi-anæsthesia resulted. There was naked-eye degeneration of the pyramidal system of fibres on the left side of the cord, as in Case 45; but it did not extend to the pyramids in the medulla, and there was no gross lesion of the central convolutions or occipital lobes. As a rule, after seizures affecting one side, say the right, there is temporary hemiplegia, or hemiparesis, or temporary aphasia, and there may be hemianæsthesia. Usually with each series of seizures the speech affection characteristic of general paralysis becomes more marked.

Apoplectiform Seizures. — These may be manifested in different degrees of severity, by slight fainting fits, brief lapses of consciousness described by the friends as "a look of bewilderment," perhaps followed by a transitory aphasia, word deafness, word blindness, or verbal amnesia, or the patient is unable to express general ideas correctly, and the words that he utters have no logical sequence, or may be even meaningless gabble. Such conditions of speech defect may, or may not, be accompanied by transitory hemiparesis, monoparesis, or facial paresis (vide Cases 54, 56). Such seizures may precede by months or years all other symptoms. Transitory defects of speech lasting a few hours, a few days, or even a few weeks, are particularly suggestive of two

diseases—syphilitic endarteritis and general paralysis. a history of syphilis and signs of it will in all probability be discovered in either case, and whereas the one is capable at least of partial, if not of complete recovery, and the other, general paralysis (a progressive degenerative disease), is absolutely fatal, it is of great importance in the treatment and prognosis to determine from which disease the patient is suffering. The presence of Argyll-Robertson pupils is in favour of general paralysis, for in syphilitic brain disease it is much more common to find the pupils inactive both to light and accommodation. Mental symptoms characteristic of general paralysis may not be present. An hereditary history of insanity would favour general paralysis, as, too, any of the symptoms of tabes dorsalis (see Cases 53, 54, 56). Very occasionally, as in tabes, syphilitic endarteritis may co-exist with the primary degenerative disease.

Mental Symptoms.—Our psychical condition, particularly that relating to the feelings and emotions, oscillates without ceasing about a mean point of equilibrium, and the extent of oscillation within the limits of health is dependent upon individual temperament and the circumstances of environment. Difficult as it is to fix the normal in the physical organism, how much more so in the psychical?

Above and below the mean point of equilibrium are grades of pleasure and of pain, which are reflected to the muscles of expression, causing synergic alterations in their minute tensions. Every passing feeling is thus reflected, so "that there is no art to find the mind's construction in the face."

Only those who have had the opportunity of observing the feelings, emotions, intellect and actions of the individual closely, and for some considerable time, can correctly appreciate a change of character, of volition, of intelligence, and thus gauge the earliest signs of the insidious and progressive mental change which usually precedes the more obvious and obtrusive symptoms and signs of brain degeneration. Long before the patient is admitted to the asylum, symptoms indicating a change of character may have been noticed by the wife, relatives, or associates in business. If

the man is married, the wife may tell you that months or years before she had become aware of his being afflicted with insanity, she had noticed a change in his disposition. Previously affectionate and kind, of an equable temperament and happy disposition, he has become subject to fits of temper; or sullen, morose, depressed, and often neglectful of her and the children. Or she has noticed that he worries over the least trifle; accustomed to act independently, confident in his own judgment, he loses all self-reliance, and worries her over the smallest details regarding his actions. He may be restless and excitable, or sullen and moping, and he has become a man of varied moods, and unable to fix his attention on any subject for any time. Or the history sometimes points to the patient having been filled with morbid suspicions, which later become fixed delusions of persecution, causing him perhaps to get up in the night to look for burglars, and to hide his valuables. These delusions and fits of temper may impel him to threaten or even attempt suicide or homicide, and she may be afraid of her life and Again, the husband who always that of her children. brought his money home at the week end, may have neglected to do so, and have become extravagant, boastful, and addicted to drink. Other instances occur of quiet, sedate and staid individuals exhibiting an antithesis of character, giving way to amusement, gambling, immorality, vice and intemperance. Sometimes the prodromal period may be marked by flashes of genius or exceptional brilliancy of artistic or intellectual power. There is nearly always, however, a failure of concentration and steadfastness of purpose to carry the schemes to fruition. The wife may have noticed that the patient has become careless about his personal appearance, untidy in his dress, forgetful of his business or his home affairs, especially relating to events that have recently happened, his mind being absorbed by ambitious schemes which come to naught, speculation, gambling or betting. These prodromal signs of a disordered mind may precede or be associated with early or well-defined symptoms of cord affection. The brain would show at this stage only slight macroscopic change, but definite microscopic changes.

Not infrequently tabo-paralytics become lustful, and their attempts to satisfy their increased sexual desires leads them to adultery and immorality, which may get them into trouble in the police-courts, and their disease may then be discovered. Too often there is a history of the home being broken up, and the wife and children left destitute, showing the necessity of an early recognition of this disease. A condition of satyriasis is usually followed by impotence, and the history related to me by several patients, but which I have not included in the notes of the cases, shows that sexual perversions may arise in consequence. Satyriasis is not infrequently an early symptom of tabes, and when this is combined with mental affection, it may be associated with delusions of extraordinary sexual power, which remain as a fixed idea even when impotence has supervened.

The delusions may take another form; the patient becomes suspicious of his wife's fidelity, and on this account he may become dangerous to her and others. The most common mental affection which brings a tabetic or taboparalytic into the asylums is "acute mania," of which we may consider that there are four types.

- (1) Acute mania from which the patient completely recovers. This form is generally due to a combination of several of the following factors:—(a) toxins from without; usually alcohol; (b) toxins from within; (c) head injury, business failure, mental shock, worry and anxiety owing to pain suffered, sleeplessness, knowledge of suffering from an incurable disease, onset of optic atrophy ending in blindness, impotence, distress and pain occasioned by visceral crises; (d) inherited psychopathic temperament. (Cases 28, 29, 30.)
- (2) Acute mania from which the patient does not recover, in which the brain affection becomes chronic and associated with delusions, hallucinations, and illusions, accompanied by dementia, which, however, is usually non-progressive, caused by the same factors as above; but frequently there is a marked hereditary history of insanity in the family (Case 25).
 - (3) Acute mania becoming sub-acute, then subsiding

completely, associated with dementia which is non-progressive; often a great mental improvement takes place, leaving only traces of intellectual enfeeblement. Such cases are usually tabetics who either in the earlier or later stages of the disease have taken to drink. After admission to the asylum the poison no longer acts upon the nervous system, and the dementia which persists is proportional to the organic destruction of the cerebral cortex by the alcohol (Cases 70, 71). It is extremely difficult to decide whether or not these cases are tabo-paralysis, in which the disease-process is arrested by the removal of exciting factors. I have seen a few cases of absolutely certain general paralysis arrested in progress for years. The patients were even discharged as cured (sic); within a few months or less they are back at the infirmary to be re-certified, and sent back to an asylum, where they die within a short time. Presumably they have been unable to stand the mental stress outside the institution, and should not have been discharged.

Many instances of the almost immediate effects of mental shock in inducing an acute exacerbation of the disease have come to my notice. The cause is sometimes avoidable—e.g., a quiet melancholic general paralytic developed acute homicidal and suicidal mania the same night after hearing the fatal nature of his disease discussed by the physician in a ward. A patient who had so far recovered that his discharge from an asylum had been considered advisable, was told by a friend visiting him that he was suffering from general paralysis; this preyed upon his mind, and the disease-process, which was only smouldering, was fanned into flames, and within three months he died from the disease. The same applies to tabes dorsalis, the disease progresses when the patient is subjected to bodily stress, or gives himself up to sexual excitement, drink, and debauchery.

(4) Mania, frequently with grandiose delusions typical of general paralysis, accompanied by symptoms and physical signs of tabes (more or less defined according to the stage of the cord affection), associated with dementia, which, after the subsidence of the mania, is found to be progressive, and is usually accompanied by characteristic defects of speech, verbal and written. The acute mania from which the

patient suffers may be partly due to alcohol, partly auto-toxic in origin.

As in general paralysis, cases of tabo-paralysis or tabes may be accompanied by various degrees of mental depression, with delusions of persecution. These may be cases of tabes with insanity, or tabo-paralysis of the melancholic type.

Hallucinations are of great importance because they exercise a powerful influence, even more powerful than perceptions, on the intellect and volition of the patient. Many cases of so-called hallucinations are rather of the nature of pseudo-hallucinations or illusions, for they are excited by peripheral irritation. I have already referred to those relating to the skin and viscera in tabo-paralysis. many of those cases definite lesions were found post mortem to account for the symptoms manifested during life. cases where there has been almost complete destruction of the posterior roots, there have still been the lightning pains and visceral crises which have been insanely interpreted. Many of the tabetic cases of very old standing still suffer with the lightning pains and visceral crises. All the while there are any rootlets left undestroyed by the disease, pains may occur and radiate all through the sentient grey matter, each decaying fibre serving as a fulminating agent. Among the many cases of optic atrophy leading to partial or complete blindness were a number who suffered with visual hallucinations—viz.: Cases 59, 64, 70. Complex visual hallucinations are usually of human forms or of animals—rats, cats, mice, lions, tigers, snakes; the human forms are generally policemen, burglars, dead relatives, or people who were supposed enemies; and like auditory hallucinations they would tend to engender and aggravate delusions of persecution. is remarkable that people who are quite blind should thus suffer from visual hallucinations, but it accords with other facts. Uhtoff, in a recent monograph, has recorded a case of tabic optic atrophy with visual hallucinations, and he refers to the fact that numerous cases have been recorded of blindness with visual hallucinations due to various causes. Some of my patients were not, however, absolutely blind, and the

hallucinations may have been caused by the irritation of the progressive death of the fibres. One case in particular which, however, was a general paralytic is of very considerable interest in this respect: the patient was admitted with acute mania a potu, placed in a padded room, and while there he was the subject of visual hallucinations. When I first saw him he said black devils came and perched on his nose and put stinking things up his nostrils and nasty things in his mouth. I found he had Argyll-Robertson pupils and I expressed the opinion that he had general paralysis as well. Examination of the eyes ophthalmoscopically showed numerous hæmorrhages around the disc, and chorio-retinitis. A fortnight later when I saw him, and, presumably, the effects of the acute alcoholism had passed off, the hallucinations had changed. He now said angels came and moistened his lips with sweet things and exhaled sweet perfumes up his nostrils. He exhibited many other signs of grandiose ideas. The retinæ were examined after death and the observations during life confirmed; likewise the degeneration of the optic nerves was found microscopically, vide photomicrograph (fig. 7). It must not be supposed, however, that the majority of cases of visual hallucinations are due to peripheral irritation caused by disease of the retina or optic nerves; in fact they are more likely to occur from a morbid condition (functional or organic) of the higher ideation centres, presumably situated in the angular gyri. Uhtoff has described, and Henschen has collected, a number of cases of hemianopsy due to destruction of an occipital lobe or the radiating fibres, and in these cases visual hallucinations have occurred on the side upon which the hemianopsy was. The only case of hemianopsy that occurred among my cases (Case 45) did not suffer with hallucinations of vision; therefore, destructive softening of the occipital lobe does not necessarily, even in a taboparalytic, produce this condition; it may be presumed that in those cases where hallucinations occurred, there existed a morbid functional or organic disease of the corresponding ideation centre of vision, which was excited by the irritation of its associated diseased perceptive centre, or the peripheral

structures (retinæ and optic nerves) connected therewith, vide Case 26. This morbid condition is due either to inherent instability or general toxæmia, the combination of factors being sufficient to produce the hallucinations.

The visual hallucinations were generally associated, like the auditory, with delusions of persecution. In one case a condition of *macropsy* occurred. The patient, who was a

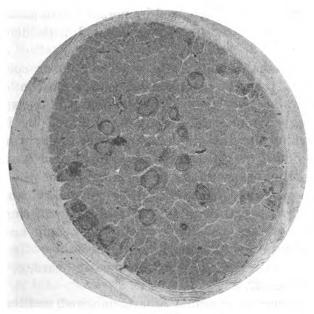


Fig. 7.

Photomicrograph of a section of the optic nerve, stained by Marchi method. The black circles indicate bundles of fibres containing abundant degenerated fibres; it will be observed that not more than 15 per cent. are affected, and these doubtless corresponded to the paletus of chorio retinitis observed during life.

Magnification 25 diameters.

very intelligent man, said everything appeared much larger than natural. Another patient, suffering with a curious complex of symptoms (Case 72), complained of things moving which were stationary. He had very sluggish re-acting pupils, no nystagmus, but some difficulty in fixation of the eyes. He also complained of inability to estimate size of objects; sometimes objects and persons appeared much too large, sometimes much too small. People coming in at the door

of the ward appeared like babies. This failure in judgment of size came on usually towards the end of the day, but it could be sometimes produced by making him look steadily at a distant object.

The occurrence of hallucinations in one sensory area is favoured by hallucinations in another, thus the onset of one set might induce the other.

Auditory hallucinations were frequently combined with visual, and generally occurred in persons with an hereditary history of insanity; usually associated with delusions of persecution.

Auditory hallucinations may be simple or complex; if the latter, patients complain of noises in the ears like rushing water or a steam whistle, ringing of bells, banging and firing of guns; these may be followed by indistinct voices which become gradually more distinct; voices may be heard in the distance, or close to, or within the patient; they may relate to persons whom the patients have known and (from a real or imaginary cause) have associated with real or imaginary pains or sufferings. The voices heard are usually condemnatory and accuse the patient of immorality, vice, crime, or brutality. In females, obscene sexual expressions are frequently heard, or children crying (Cases 62, 63, 66 and 68).

An instructive example of systematised auditory hallucinations is afforded by Case 25, who said that two nurses from the infirmary, where he was first taken, continually followed him, and carried on a conversation about him, turned on electricity and pulled his legs at night. He associated the lightning pains and the cramp-like spasms with the voices that he heard talk to him. This case is of exceptional interest because for years the same delusions and hallucinations have persisted. Like most such individuals the hallucinations are worse just before going to sleep; they could be produced by covering his eyes, as I found when testing his skin sensibility. He then said he heard voices say "Too bad, Hoskyns"; again, when he heard the metronome going, he heard the voice say, following the rhythm of the metronome, "You must have been a

lunatic to run away from Sydney Street." This was precisely the same sentence which he said he heard, and of which we had a note, when he heard the metronome many months previously. This man also had delusions of poisoning, which he associated with the voices. He had had visual hallucinations, but later they ceased to trouble him, and voices were not so distinct as formerly.

Frequently auditory hallucinations occur when the individual indistinctly hears the confused sound of voices at a distance. The patients are suspicious and morbidly inclined; therefore, if they see people talking in the distance and they do not hear what is said, by a kind of morbid association the hallucinatory voices return.

Deaf people, or partially deaf people who are insane, are especially liable to hear voices and to be filled with morbid and suspicious delusions, and in the first volume of the "Archives" I recorded the case of a deaf mute who suffered with auditory hallucinations; this seems almost paradoxical, but he had been taught lip language and the power of communicating his ideas; therefore, it must be presumed that his kinæsthetic centres were associated with his auditory ideation centres of words, although the ordinary word perceptive centre was functionless.

Another tabo-paralytic patient, a musician, who suffered with lightning pains, heard not voices, but continually the playing of an orchestra; he associated it with the electric wires and electric currents in his body; he continually heard it whenever he concentrated his attention, and being a professional flute player, he whistled very accurately the melody he heard in his mind, and was quite surprised that I did not hear it also.

A blind tabo-paralytic woman (Case 64), who was subject to visual hallucinations, imagined that the people she heard talking, came into her bed to assault her at night, and it was these hallucinations and delusions which brought her to the asylum. The existence of organic degenerations which occasionally, even in sane people, cause rectal and clitoris crises may, in insane subjects, be a source of peripheral excitation, and be insanely interpreted.

Another interesting example of an hallucination giving rise to a systematised delusion, is that of Case 26, whose wife committed suicide eighteen months previous to his admission to the asylum. For a long time he persisted in the delusion that he had opened his wife's grave, found the coffin empty, and that she had come to him since he has been in the asylum, and he had conversed with her. These delusions with regard to dead relations are not infrequent; sometimes cases occur in which the patient has hallucinations and delusions that relatives who are still alive are dead; that they have been at the funeral and seen them buried; it is as it were a dream which has persisted as a fixed idea.

Delusions.—Delusions of persecution are common in tabo-paralytics; it is natural that they should put an insane interpretation upon their pains and sufferings, but I have been rather struck by the fact that this condition applies more to tabetic patients with associated insanity than to tabo-paralytics; for grandiose delusions, exaltation, bien-être, supervene very frequently in tabo-paralysis. As the mind becomes affected, and especially after an attack of mania. leaves the patients demented, they cease to complain of pains, and the cord symptoms both subjective as well as objective, are less obvious, and may even almost disappear. The subjective symptoms disappear with the progressive destruction of the seat of consciousness, and this may account for the well-known fact that paralytics do not suffer much pain from bodily injury or disease, and hardly ever complain; so that a patient may have a very severe and painful affection of the internal organs without manifesting any subjective or even objective symptoms during life. In such a painful disease as dysentery, with its attendant gripes and tenesmus, I have been struck with the fact that demented patients seldom complain or evince signs of pain.

In 28 per cent. of the sixty asylum cases of tabes, the patients were affected with delusions of persecution, poisoning, electricity, &c. In three-fourths of such patients, there were either auditory or visual hallucinations, often the two combined; and all of them, with one exception, had an

hereditary history of insanity. Nearly all the cases of hallucinations had an hereditary neuropathic or psychopathic history. The grandiose cases were apparently much less subject to hallucinations of vision and hearing, and an hereditary history of insanity was comparatively less frequent. Grandiose delusions alternate occasionally with those of persecution; mania gives place to melancholia, and restless excitement to stupor. The grandiose delusions do not seem to be so persistent as those of persecution, and it was frequently noted in the sixty cases collected that they passed off after the patient had remained in the asylum a little while, and the acute delirium had subsided. It seemed that some were partly due to the effects of acute auto-intoxication.

The delusions of persecution associated with electricity in the body, the poisoning of food, twisting of the bowels, withdrawal of the semen (impotence), bad smells and tastes, frequently associated with hallucinations of sight and hearing, have, I conclude, an organic basis in the tabo-paralytic, and persist generally throughout the illness, although different false interpretations may be put upon the abnormal sensory stimuli. The grandiose delusions were often simply confused, incoherent, and grotesque exaggerations referring to the patient's possessions or ambitions. Thus in E. C. R. and his wife conjugal paralysis (Case 69), the prevailing delusion in both was the ownership of all the furniture of the asylum; the man was a furniture dealer. Another man was a cutter in an army tailoring establishment; one of his delusions was that he was a colonel in the Lancers; another that he possessed diamonds; but the fact that he was a Polish Jew, who had for a long time been in South Africa, makes it possible that he was once in the illicit diamond trade.

Dementia

Progressive dementia is the most constant symptom in general paralysis; it also exists in all cases of tabo-paralysis, but as a rule, according to my experience, death takes place

before there is advanced dementia more frequently in cases of tabo-paralysis, than in ordinary cases of general paralysis. This is but to be expected, since the degenerative process which has affected the central nervous system has either been in progress in the spinal cord some considerable time, or when it attacks both the spinal cord and the brain simultaneously, death from one of the many complications arises sooner; and the fact that both cord and brain are affected indicates a more widespread process of decay. A man who has suffered with tabes for five or six years, and is then attacked with brain symptoms, as Case 46, is in a lower state of vitality than a man who starts with brain symptoms; but if we consider that the disease is a single morbid entity, and began with the cord symptoms, then the duration is longer. Be that as it may, it is a fact that, in cases with tabes dorsalis, at the autopsy one finds as a rule less brain wasting than in an ordinary case of general paralysis. majority of the cases recorded exhibited either a slight or only a moderate degree of brain wasting, and we know that the dementia, generally speaking, is proportional to the extent of the brain atrophy.

The following cases, 45 and 48, were attended by leftsided seizures during life, the epileptiform fits being the immediate cause of death; these patients did not exhibit marked dementia, and at the autopsy one found very great wasting of the right hemisphere. This was particularly so in Case 45. Another case, 54, with right-sided seizures exhibited marked progressive dementia, and at the autopsy the left hemisphere was found markedly wasted, and weighing much less than the right. Seeing that the speech centres are situated in the left hemisphere in right handed persons, it may be considered that the mental state did not really indicate a more marked dementia, but a greater difficulty in expression of ideas and the ideation of words. Although both hemispheres are simultaneously used in all mental processes, and it is not suggested that the left hemisphere is used independently of the right, even in speech, yet it is through the left hemisphere and its centres connected with verbal and written speech that the brain as a whole carries on all abstract processes of thought;

therefore, it must be allowed that one could ideate words and think in the abstract to some extent without the action of the right hemisphere, but without the left hemisphere this would be impossible.

The most dementia occurs when both hemispheres are wasted. In some acute cases where there has not been time for the products of decay to have been removed and absorbed, there may be extensive dementia without very great wasting, but examination of the tissue microscopically shows an acute cell destruction, generally associated with marked vascular congestion and cell-proliferation in the peri-vascular lymphatics. It was remarkable in some cases, especially Case 31, how cord and brain symptoms seemed to alternate, as if, while the process was destroying the structures in the cord, in the brain it ceased, or was in abeyance.

Note.—The morbid anatomy and pathology will be described after the cases.

CASES.

GROUP 1.

A summary of the clinical symptoms of cases of tabes which have presented some unusual clinical phenomena, or are adapted for explanation of some essential feature of the disease.

- Case 1.—Optic atrophy at 19. Preataxic condition for twentyeight years, probably due to congenital syphilis, although no history was obtainable.—(Bethnal Green Infirmary.)
- J. E., aged 47, lost his sight between 19 and 20; he accounts for it by a blow on the head when 11 months old. Twenty-five years ago he attended St. Bartholomew's Hospital, under the care of Dr. Hensley, who then said that he had locomotor ataxy. He is very positive in saying that he had nothing to do with women before he went blind. He says that he does not see how it can be locomotor ataxy, for up to a few weeks ago he was able to walk eight or ten miles a day. Four years ago he was treated in the London Hospital for severe gastric crises. He has now gastric attacks occasionally, which last two or three days. He has a feeling of a tight cord round the waist, cutting pains in the legs, and a somewhat ataxic gait. Cutaneous sensation is nowhere lost in the legs, but light tactile sensibility is lost over the thorax and back between the fourth and tenth segments inclusive. In this region also there is some hypalgesia and considerable delay. The joint sensation is good everywhere except in the great toes. Knee-jerks and triceps jerks lost, moderate hypotonus in the legs. The pupils had had atropine put into them, they could not therefore be examined. Optic atrophy of old standing.
- Case 2.—Case of hereditary syphilis in a child, whose father died of general paralysis. At the age of 9 paroxysmal attacks of severe pain in the abdomen associated with vomiting and sometimes diarrhæa. A previous history of ten fits. Admitted to Charing Cross Hospital, subsequently to Darenth. Absent knee-jerks, optic atrophy, chorio-retinitis, pupils dilated, equal, inactive to light and accommodation; trunk, light tactile anæsthesia and dislocation of hip.
- P. C., aged 9, admitted to Charing Cross Hospital, May 21, 1899, for attacks of vomiting and pain in the abdomen.

Family history.—Father died at Banstead of general paralysis of the insane. It may here be remarked that the notes of his case did not refer to syphilis or any signs thereof on his body, but his offspring indicates that he suffered with this disease. Mother had two children born dead and one miscarriage. The patient began to have the attacks of pain and vomiting at the age of 7, and they became as frequent as once a week. The child also complained of pains in the bones and joints, and two years ago she had swelling of the dorsal surface of both feet.

Condition on admission.—She is well nourished, and presents signs of hereditary syphilis in well-marked rhagades on the lower lip and at the angles. Complete loss of knee jerks, but no other physical signs are mentioned in the notes, although they show

that all the organs were carefully examined.

At Darenth in June, 1899, I saw her. She had then recovered from an abscess of the jaw and a pelvic abscess which had been opened; the attacks of vomiting still persisted, attended with radiating pains. Knee-jerks absent. Pupils dilated, unequal, inactive to light and accommodation.

December, 1901.—The following notes as to her condition were kindly forwarded to me by Dr. Beresford: Pupils dilated, equal, inactive to light and accommodation. Very defective vision of left eye, ophthalmoscopic examination shows chorioretinitis and white atrophy of the disc. Optic atrophy of the right eye and chorio-retinitis. Knee-jerks absent both sides, triceps jerk present, superficial reflexes absent. Anæsthesia of chest to light tactile sensations from the third rib to the upper border of the sixth rib, extending lower in the left axilla than in the right. The rest of the body and limbs are normal to touch and pain. Very little loss of sense of position of joints. She has slight incoordination, and sways rather when standing with the eyes shut, but she has a dislocation of the hip. She still suffers with gastric crises, attended by severe pain. Her mental condition as a rule is normal, sometimes bites her tongue, and passes her urine and motions under her. At other times she has control over the sphincters, and responds to the calls of nature. She has thickening of the left femur in upper half, and a dorsal dislocation of the head of the right femur. There are no teeth in the lower jaw, and the alveolus is absorbed just like an old woman's jaw. The alveolus of the right half of the upper jaw is gone, and all the teeth, except one central incisor. Left side of the upper jaw one upper molar, first and second bicuspids, lateral and central incisor are still left. (?) Result of mercurial treatment or atrophic bone lesion.

Case 3.—Preataxy. Gastric crises of twenty years' duration still severe in character. Impotent five years.

C. E. M., sailor all his life up till the last eight years, since then a publican: later on an Admiralty messenger. Married.

Family history.—No direct neuropathic history. One of a family of seventeen children, five of whom are now alive. Patient does not know whether his mother ever had any miscarriages. His eldest brother died at the age of 50, from some brain trouble.

In 1878 he contracted syphilis (hard sore, scar still remains). In 1881 he was engaged stowing away provisions in the ship's hold, and strained himself. He had an inflammatory swelling in the groin which was lanced on two or three occasions, and from which he was not entirely free for three months. Patient not a free drinker.

Present illness.—Patient dates the onset of the present illness after the occurrence of the buboe in 1881. The first thing that occurred was a pain in the back, sharp in character, which extended both transversely and vertically all over the back: at first the pains only lasted about a day. As soon as they became acute vomiting commenced, and relieved them. There were no pains in the region of the epigastrium. At first these only came once in six months, but later became more frequent and more severe. In 1895 patient married; at this time the attacks of pain occurred about once in every three months and would last three to four days. The attacks of vomiting would last two to three hours, but now did not relieve the pains. He now began to notice that on washing his face, he had a tendency to fall down, and began to have very sharp lancinating pains shooting down his legs. After marriage his sexual powers declined. The desire for intercourse was still present, but the erection would die away without full performance of the sexual act; in fact (since 1895) he has never been able to completely perform the act. For the last three to four years he has had a sensation of wool under the soles of his feet. Also has had occasional attacks of difficulty in passing his water, not amounting to actual retention. The bowels are regular. For the last five or six years he has had a sense of constriction round his body. This feeling is synchronous with the pain. He has never suffered with diplopia. He has noticed no change in his gait nor powers of walking. His principal trouble is the increase in the frequency and severity of the pains, which have become very bad. They come on now every two or three weeks and last for a few days or weeks. Associated with the pain is intense sickness, which occurs whether there is food in the

stomach or not. This vomiting persisted on the last occasions for twenty-four and fifty hours respectively, the attacks coming on at an interval of about half an hour. It is extraordinary how soon the patient recovers and is able to take ordinary food after such severe attacks; this then, resembles sea-sickness. Patient has lost flesh considerably during the last few years, but does not feel weaker except after one of his bouts of sickness.

Present condition, January 19, 1900.—Nervous: (a) Motion— Hand grip unimpaired. Muscular power in legs good; the muscles show no signs of atrophy, but are flabby. No incoordination of movement. Slight hypotonus of muscles in right leg. (b) Cutaneous sensation was charted and showed hyperæsthesia over the thorax, but no definite anæsthesia. Muscular sense unimpaired. Reflexes—Superficial:—Plantar reflex well marked on the left side. Plantar reflex absent on the right side. Cremasteric— Present on the right side, but very sluggish; brisker on the left side, but less marked than normal. Epigastric—Brisk on both sides. Deep Reflexes-Knee-jerks absent on both sides. Gait-Stands pretty well on one leg. Stands erect with eves shut. Ocular—Pupils slightly contracted and unequal, left smaller than right. No reaction to light, but to accommodation. Gastric crises still continue and he is now suffering from diplopia owing to paralysis of the left external rectus.

- Case 4.—Transitory paralysis of left external rectus, gastric crises, preataxic condition, knee-jerks present both sides, cutaneous thoracic anæsthesia unequal on two sides. Brother died in asylum of general paralysis.—(St. Pancras Infirmary, August, 1900).
- J. M., aged 45, occupation pavior and mason, work hard; married, has had sixteen children, six of whom are alive, one miscarried, and three born dead in succession; denies syphilis.

Family history.—Brother died in Colney Hatch two years ago of general paralysis, aged 36. He lived a very rackety life, and was the subject of syphilis, undoubted.

History of illness.—Four years ago he had double vision and paralysis of the left external rectus, gastric crises. He has no ataxy, no pains in the limbs, no paræsthesia, no difficulty of walking in the dark. The knee-jerks are present on both sides upon reinforcement, triceps and wrist tap both obtained, no loss of sense of position, joint sensation and localisation perfect. The only symptoms are double vision, slight nystagmus to the left,

Argyll-Robertson pupils and the gastric crises previously mentioned, which were extremely severe, causing him to shout out, and were only relieved by morphia. He is sick with no food in his stomach, and during these attacks he has a deep epigastric pain, and pain under the right shoulder. The vomit is very frequently bilious. There is no enlargement of the liver or gall bladder. There is some dilatation of the stomach. There is light tactile anæsthesia over the fourth, fifth, and sixth segments on the right side, and the fourth segment on the left side, which is of interest, seeing that it is on the right side that he feels the pain when the crises occur. He has no analgesia or thermal anæsthesia. His answers are reliable.

November 14, 1901.—Patient is very depressed, still suffers with gastric crises. Complains of shooting pains down the spine. He has diplopia and paralysis of the left external rectus. A. R. pupils equal 3.5 mm. He complains also of pains across forehead between the eyes (probably sympathetic associated). Knee-jerks present right side; present on reinforcement on the left. Hypotonus more marked on the left than right. Retention of urine. Cutaneous disturbance unchanged.

Case 5.—Tabo-arthropathy, preatance condition for twenty years.

J. L., aged 63. At the age of 43 he came to Charing Cross Hospital suffering with lightning pains, Argyll-Robertson pupils, absent knee-jerks, and a large swelling of the right shoulder joint, preceded by pain, and greatly distended with fluid. It rendered him unable to follow his occupation of stonemason. He weilds a 4-lb. hammer with the right hand to strike a chisel held in his left hand; both the metacarpophanlangeal and the phanlangeal joints (especially of the thumbs), also the left elbow and wrists, present nodular deformities, like that of rheumatoid arthritis. The joints of the lower limbs exhibit little or no deformity. He admits having had a chancre when he was 22 years of age.

December, 1901.—The patient has been re-admitted to the hospital. He is still in the preataxic stage, knee-jerks and triceps jerks are absent, lightning pains are now present and very severe, pupils unequal, right four, left three-and-a-half mm., inactive to light, but react somewhat sluggishly to accommodation. There is no ataxy in the gait; Romberg symptom is not present; there is no loss of sense of position in the joints, or any marked incoordination of the lower limbs; owing to joint deformities it is impossible to say whether there is any in the upper limb or not.

There is no trunk anæsthesia, and, with the exception of a little confusion of the prick of a pin with the touch of a finger in a few spots in the lower part of the peroneal borders of the limbs, I could discover no defect of sensation anywhere; he has never had any trouble with his bladder, or any other visceral symptom beyond the attacks of vomiting mentioned. The right shoulder joint was tapped some time ago, the swelling has therefore gone down. Skiagrams of the various joints have been made; there appears to be absorption of the head of the humerus and ankylosis. Considering the deformities of the hands there are very few osteophytes, and most of the swelling must be due to the capsules and the synovial membrane round the joints. The left elbow joint does, however, show a considerable amount of osteophytic growth. The joint disease in the upper limbs has produced a fair amount of muscular atrophy.

This case is of interest in several ways, firstly, because the diseased condition of the joints of the upper limbs was probably connected with his occupation of a mason, which he had followed for thirty years; secondly, the absence of bladder trouble and the long period during which the patient remained in the pre-ataxic stage. The sense of position in the joints, in spite of the deformities, remained unchanged.

Case 6.—Woman. Advanced tabes, well-marked signs and history of syphilis. Brother died in asylum of general paralysis.

—(Bethnal Green Infirmary.)

E. C., aged 48, married. One child born dead eighteen months after marriage, no pregnancies since, papery scars all over body, undoubtedly syphilitic, occupation sewing machinist. Brother died in an asylum of general paralysis, aged 46. Her illness commenced with lightning pains, numbness in the hands, followed by ataxy.

Present state.—Marked ataxy, Romberg symptom, loss of joint sensation in the feet, legs, and hands. Deep reflexes lost, and loss of sense of position in both upper and lower limbs. Superficial reflexes, plantars absent, epigastric present. Pupils unequal, left irregular 3½ mm., right 5 mm. inactive to light and accommodation, marked hypotonus of legs.

Sensation.—Thoracic anæsthesia in area of distribution of seventh and eighth cervical upper dorsal, third, fourth, and fifth lumbar, first sacral, and hyperæsthesia in areas between. Imperfect localisation over the lower part of abdomen and

upper part of legs. Pricking with a pin is described as a touch all over the body.

Case 7.—Case of gastric crises admitted for acute intestinal obstruction. Operation contemplated; contracted pupils with inaction to light attracted attention and averted operation.

W. C. Labourer. Single. Admitted Charing Cross Hospital, August 17, 1900, for violent pains in the abdomen.

Family history.—Nothing of interest.

Personal history.—Influenza and pneumonia three years ago. Syphilis contracted fourteen years ago (hard chancre, secondary eruption, falling out of hair). Treatment (?)

Physical signs.—Has been troubled with his bladder for the last eight weeks. Has great difficulty in passing his water, and intense pain when he endeavours to micturate. Sometimes has difficulty in passing his motions. Has been a free drinker for the last two years. Patient first experienced difficulty in walking two weeks before admission. He has had peculiar sensations in the abdomen for the last four or five weeks, such as sense of constriction, like a tight cord, and at times, sensations of cramp. Shooting pains have occurred in the right leg only. Has noticed failure of sight for two years, and cannot now see to read.

Present illness.—On Friday morning, August 17, he woke with violent pain in the abdomen; this became so bad that he came to the hospital. When seen he was breathing very rapidly, and appeared to be in great distress. Pulse quite good, and he had not been sick. On examination of the abdomen, the lower part of it was found to be slightly distended, but everywhere tympanitic, except in the supra-pubic region. Abdominal movements good. On palpation nothing definite was felt. There did not appear to be any tenderness, and the abdominal wall was equally soft all over. What swelling there was, was most marked over the left inguinal region. At first there was distinct gurgling all over the belly; palpation seemed to aggravate the pain. With a diagnosis of probable acute intestinal obstruction (volvulus?) he was admitted. His rectum was then examined, but nothing abnormal was found. As the pain increased, and the patient was becoming slightly delirious, 1 grain of morphia was given and an enema ordered. When the latter was administered, the patient was sick; after this he quieted down, breathing quite quietly and sleeping. At five a.m. he was seen in this condition, and a catheter passed without attracting his attention, and 14 ozs. of urine drawn off. Specific gravity 1.005, acid, and contained a

faint trace of albumen. At seven he vomited, and continued to do so at intervals throughout the day, the vomit being brownish acid; no blood or stercoraceous smell. The pain returned as the effects of the morphia passed off. Mr. Boyd saw patient at ten a.m., and as the pulse was good (84), he decided to wait and watch for further indications. At eight p.m. the patient was complaining of pain higher up in the abdomen, and of pain in the back and loins, as though someone was pinching him in. This, combined with the fact that the pupils did not dilate during the paroxysms of pain, led at once to a suspicion of locomotor ataxy, and on examination typical symptoms were found. While patient has been in hospital, he has on several occasions been quite delirious, and has got out of bed and walked aimlessly about the ward: It was found that these attacks were associated in some peculiar manner with a full bladder. In these delirious attacks he suffered with visual and auditory hallucinations. He stated that he heard numbers of men continually tramping up the stairs in the night, and that they came and marched through the ward like an army.

Examination of present condition. — Well-built and wellnourished man. Motor power.—There is no wasting of muscles, and the power in the legs and arms is good. Hypotonus of muscles is well marked. When patient is lying on his back the leg can be flexed to a right angle with his body when the knee is extended. Sensation.—The buccal mucus membrane on the right side, also the tongue (right half) were anæsthetic and analgesic, as well as the whole cutaneous surface of the right half of the body; but the cornea was very sensitive to the slightest touch. There is slight incoordination of the legs and arms. Eyes.—Argyll-Robertson pupils. There is no paralysis of the external ocular muscles. There is great diminution in the field of colour vision on both sides, and optic atrophy. Muscular sense is much impaired on the right side of the body. Gait ataxic; Romberg's phenomenon well marked. Reflexes.—Knee-jerks absent on both sides. Plantar, cremasteric, and epigastric are considerably diminished.

Case 8.—Case of (probable arsenical) neuritis from beer drinking—attacks of vomiting—pains in legs and absent knee jerks.—Thought to be tabic with crises, but pupils normal.

W. W., aged 70 years, occupation boiler maker, married, five children, one dead. He has worked in the North of England, having been sent there.

Previous history.—Has had jaundice three times, accompanied by retching and attacks of sickness. He was brought into Poplar Infirmary suffering with vomiting, sneezing, and itching of the eyes. He was unable to walk or stand, had burning pains in the legs and in the soles of his feet and cramp.

Since admission.—He has had no attack of sickness for four months, and from the first there has been a steady improvement. At the present time there is great tenderness in the calves of his legs, and the knee jerks are absent. He has had delirium tremens, and has drunk large quantities of beer. There is marked pigmentation of the legs. The pupils react to light and accommodation.

Case 9.—Preataxic condition. Optic atrophy, interesting syphilitic history.

G. P., aged 48. Occupation, ship's steward, hard chancre twenty-five years ago, followed by sores on the body and rash. Treated three months. Married at the time, but away from his wife on a voyage, and he remained away 3½ years. He was infected with syphilis in 1876, and returned home in 1878. His wife, who had had one child in 1873, now suffered with three successive miscarriages, one in 1878 and two in 1879. In 1880 she became pregnant, child born dead, and again in 1881, when she began to give birth to healthy children, so that she has now five healthy children living. This is best shown in the subjoined table.

First child 1873, male, alive and well.

Husband, in 1874, went for a voyage lasting three-and-a-half years; in 1876 was infected with syphilis; returned home in 1878.

During 1878 and 1879 the wife had three miscarriages.

Child born dead 1880.

Second child, 1881, male, alive and well.

Third ,, male, alive and well.

Fourth ,, ,, ,, ,, Fifth ,, ,, ,,

There is no history of nervous disease or insanity in his family; he has never been a heavy drinker, but has suffered with malaria, yellow fever and cholera.

Present illness.—Ten years ago (that is, sixteen years after infection) he noticed he saw double for about ten or eleven days. Twelve months ago sight began to fail in the right eye, of which he has now completely lost the sight; there is also dimness of vision in the left eye. He has complained of no shooting pains,

numbness, formication, girdle sensation, or inability to walk in the dark, but for some time he has noticed a frequent desire to make water and occasional incontinence.

Physical signs.—Optic atrophy both sides, pupils unequal, somewhat irregular, right measures $5\frac{1}{2}$, left, $4\frac{3}{4}$ mms., inactive to light, active on convergence; limitation of field of vision on left side, but recognises colours. Knee-jerks right, brisk left, present; no paræsthesia, no Romberg symptom; no ataxic gait; no anæsthesia or analgesia anywhere. This case is of interest because, probably, the wife was not infected, for in 1881 she gave birth to a healthy child. It is quite possible that the three miscarriages in 1878 and 1879, and the dead child in 1880, were due to spermatic infection and defect of the male germinal plasm.

Case 10.—Squint, optic atrophy. Loss of smell and taste of flavours; very mild gastric attacks, only very slight sensory cutaneous disturbance of thorax, preataxic condition. Knee jerk present on one side, absent on the other.

C. F., aged 57. Occupation, barman, billiard marker, coachman, and finally shoe finisher for thirty-four years. Married at twenty, nine children in thirteen years, four alive, two died since wife died thirteen years after marriage. Ptosis and continual squint in right eye was the first symptom, occurring five years ago. Twelve months before this he had "a sore in the pipe," which healed up as the discharge was cured; the discharge only was treated. Frænum absent, two brown pigmentary patches symmetrically placed on each leg. Glands in right groin shotty. Went to Moorfields for seven weeks, and the medicine they gave cured the squint, but left the pupil large. Three years later went again owing to sight becoming misty in both eyes, and that became worse and worse (not a great smoker). Dull pain across forehead; difficulty with his work two months before Christmas. 1898. Numbness over the breast, armpits, and flanks; he knew that there was impaired sensation there. Nothing on inner side of arm. He had cramp in the calves, but no numbness in the feet. For the last few months he has experienced difficulty in passing his water; has been constipated for several years. No gastric crises. Complained of pain over pit of stomach for two years, with flatulent distension, but no sickness. The least little jerk hurt him, and he was very tender over the epigastrium. Experienced no difficulty in walking. Loss of smell since paralysis of right eye, but has a very disagreeable sensation of smell like a drain. He can taste mustard, sugar, acid, and salt, but no flavours; therefore only olfactory affected. He cannot smell or taste peppermint or aniseed (tested). He can smell ammonia. Knee-jerk present left side, but absent right side. Hypotonus both sides, angle nearly 90 degrees with body. No loss of sense of position in legs or toes, a little loss in hands. No loss of sexual power. Used to lurch to the right when he had paralysis of the right eye. Superficial reflexes all present in trunk and lower limbs. Cutaneous sensibility, anæsthesia to light tactile impressions in the fourth and fifth thoracic segments left side, and over a region corresponding to the sacral roots. No thermoanæsthesia either to heat or cold. Optic atrophy in both eyes, marked curving of vessels which are of normal size.

Case 11.—Charcot's joint, both knees, in a carpet planner, who knelt all day, slight cutaneous thermo-anæsthesia, otherwise very slight symptoms of tabes.

W. J. S., aged 56. Occupation carpet planner for twenty years (before that a carpenter) involving kneeling twelve hours a day. Married at 21, child born healthy twelve months after, alive, aged 32; twelve months later another child was born, and twelve months after that a girl, no addition since. No miscarriages. Always suffered with rheumatics, in fact for thirty years. When 18-19 had gonorrhoea which lasted three months. Patient, however, denies syphilis. Father lived to 86 years, mother to 84. No neuropathic history. Pains in legs, came on severe ten months ago. A few months later an enormous spontaneous painless swelling in the left knee: he was able to kneel on the right knee, then it became similarly affected. No pain in the legs now. No girdle sensation, difficulty with water, bowel symptoms, or gastric crises. Does not complain of unsteadiness in walking and could walk in the dark very well. Pupils, no reaction to light or pain, react to accommodation. Field of vision normal. The glands in the groin are enlarged, the right testicle is twice as large as the left, otherwise no suspicion of syphilitic residua. He has complained of pains in the legs as well as the arms, but the arms were affected later. There is not very marked alteration of sensory perception, but there is delay in appreciating light tactile sensations and slight imperfect localisation of the same, in region corresponding with the distribution of seventh and eighth cervical. upper six dorsal and the lumbo-sacral roots. There is no loss of sense of position in the hands and the patient feels quite well any movement of the toes, and he knows exactly what is being done when they are moved. Knee-jerks cannot be tested, nor hypotonus. It was remarkable that the patient's power of appreciating the painful sensation of the prick of a pin in the legs seemed to increase as the experiments were continued, as if increased conductibility had occurred. In the limbs below the knees where painful pricking was confounded with touch sensation, one observed confusion of heat and cold; generally speaking a hot test tube was thought to be cold. When tested in the abdomen, thorax or face, he made no mistakes. There are large corns over ball of little or big toes in both feet which look as if they would soon become perforating ulcers. The Charcot knee joints are very characteristic.

Case 12.—Tabic foot in a butler followed by progressive ataxy.

Marked cutaneous sensory disturbances of the whole trunk, flaccid atony of abdominal muscles, with ballooning of the belly and drawing in of the lower ribs on inspiration through the unopposed action of the diaphragm.

H. F., admitted to St. Pancras Infirmary 1898, aged 49, single, butler, denies syphilis, but has been in the way of getting it. When aged 38, first symptoms, ataxy and incontinence of urine. In 1897 spontaneous painless dislocation of right hip, Charcot's joint, $1\frac{1}{2}$ in shortening of thigh. Occupation, heavy place, long hours, standing, and heavy manual work.

Family history.—Nothing noteworthy, no history of previous illnesses. The following notes were made:

Ataxic gait, ataxy in arms, muscles well developed, deep reflexes both of upper and lower limbs lost, superficial plantar, epigastric, and cremasteric absent; marked hypotonus 10° beyond the vertical. Loss of joint sensation in legs and arms. Eyes: Two or three years before the ataxy, i.e., when he was 35, he saw Mr. Critchett for double vision which got better with a course of iodide. Pupils equal 2 mm. Argyll-Robertson, sight good. He suffers with frequent attacks of lightning pains in arms and legs, and girdle sensation. There is numbness of the hands and difficulty in buttoning his clothes. No tingling on pressure of the ulnar nerve. There is disease of the right tarsus, for the foot is much swollen in that part. It is of old standing, as it came on eighteen months before ataxy.

The abdomen of this patient is enormously distended, the lateral portions hang down flaccid; the walls are like a thin mem-

brane, devoid of fat and offering no muscular resistance. When the patient takes a deep breath, the lower ribs are distinctly drawn in, but the thin abdominal walls are bulged out by the intestines which are pressed forward by the descending diaphragm.

There was almost complete absence of light tactile sensibility over the legs and trunk up to the second space, extending a short distance down the upper arm on the inner side. There was a belt of analgesia over the fifth and sixth thoracic segments, and there was also analgesia of the legs extending half way up to In the same regions there was some thermothe knees. In other portions of the trunk and extremities anæsthesia. where there was anæsthesia, there was either hyperæsthesia or hypæsthesia. Over the forearms and hands there were many hyperæsthetic points, and in the right forearm, the seat of recent severe pains, were several greenish yellow pigmented areas with their long axes in the direction of the long axis of the limb, which he said were once bright red, and appeared when he had the pains. They no doubt correspond to the distribution of the terminal filaments of a sensory neuron, or group of neurons, which had been intensely irritated.

The very marked sensory disturbances of the whole trunk indicated a very profound degeneration of the lower dorsal and upper lumbar roots, and this gave rise to a nearly complete loss of the reflex spinal tonus. The upper cervical roots are, however, not affected; consequently, the diaphragm is entirely unopposed, with the result the lower ribs are drawn in, and the flaccid abdominal walls protrude at each inspiration. He can contract the abdominal wall voluntarily, because the path from the cortex is still open to the spinal motor cells. If we assume that the posterior roots of the lower dorsal and upper lumbar segments contain sensory fibres from the intestines, there is probably a loss of reflex tonus of the intestines, and, in consequence, paralytic distension. He suffered some time ago with rectal crises, and for some time has required medicine to open his bowels.

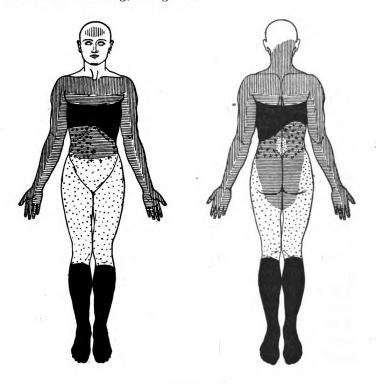
- Case 13.—Argyll-Robertson pupils, history of hemiplegia, kneejerk present on paralysed side, absent on the other.—(Hendon Infirmary.)
- J. T., aged 69; occupation basket maker; history of a rightsided hemiplegic attack ten years ago. Married at 30, no children, several miscarriages, history of syphilis, treated for some

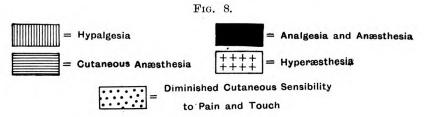
months with medicine. Pupils unequal, left a little larger than right, inactive to light, react to accommodation. Deep reflexes; knee-jerk obtained on the right side, not on the left; triceps ditto. Plantar reflexes and epigastric obtained on both sides, the former brisk. He has a hemiplegic, not ataxic gait. He has had no pains, and neither anæsthesia nor analgesia were discovered. He is, however, very feeble mentally.

Case 14.—Advanced tabes, ataxy and cutaneous sensory disturbances, first symptom pronounced gastric crises, now ceased. Brother died of general paralysis.

C. P., aged 46, married woman, husband dead, now a nurse, no children, one miscarriage twelve months after marriage, second child only lived five months, no direct signs or history of syphilis. Symptoms began with gastric crises five years ago occuring every month or six weeks, followed later by a tight feeling round the waist. Two years later inability to stand or walk in the dark; three years ago she had a hystero-epileptic fit while in St. Mary's Hospital; later she went into the Queen Square Hospital and received Fränkel treatment without benefit. Four years ago she had bladder trouble. No neurosis or nervous disease in the family, except that her brother died of general paralysis, aged 33.

Present state.—She can now get out of bed, but is unable to walk or stand without support, but she can wash and feed herself. The muscles are not wasted, there is marked hypotonus in both legs, deep reflexes of upper and lower limbs lost, superficial reflexes absent on right, just present on the left; epigastric, present on the right, absent on the left, frequently bilateral response to right-sided stimulation. Hyperæsthesia of skin over right side (vide fig. 8). There is a good deal of ataxy in the hands; she complains of great pains, shooting and darting in character, in the right infrascapular region. On moving, the pain was greatly aggravated, no friction was detected, although she thought she was suffering from pleurisy; pain is in the region where hyperæsthesia is indicated in the chart. Joint sensibility lost in all joints of lower limbs and in fingers of upper. She has lost sensation in the ring and little fingers of the left hand within the last three months. She first became aware of this by a cramplike feeling. She complains of a deep-seated burning pain in the epigastrium, but she does not now have gastric crises. Pupils, right 5 mm., left 3½ mm., Argyll-Robertson, complains of dimness of vision in right eye, but no facility for examination. The sensory disturbances are indicated in the subjoined chart. In the dotted area there was blunting of light tactile sensibility and some delay; in the black part there was no response to pricking or touch, in the cross-shading there was light tactile anæsthesia, and in the one-line shading, analgesia.





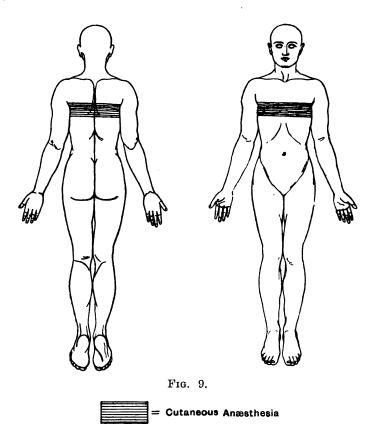
Case 15.—Tabo-paralysis, dropping out of all the teeth, and absorption of the jaw.

T. K., butcher, a patient in the Central London Infirmary, denied intemperance, also syphilis; but there are well-marked signs on the body, scars on the prepuce, enlarged glands in the

groin, large papery scars outside right shin. His work was that of a slaughterer and carrier. He has no friends, and his answers are unreliable as to family history. He can't remember when he had to give up his work, but attended a hospital many years ago. He has a markedly ataxic gait, Romberg symptom, absent deep reflexes of both arms and legs. Plantar reflexes absent; epigastric, right side brisk, left side present. Joint sensibility lost in toes and feet, hypotonus to a right angle. Pupils, right 13 mm., left 2 mm., Argyll-Robertson. He tells me all his teeth fell out not long ago, and there is great absorption of the alveolus in both upper and lower jaws. His mental state is such that his sensibility could not be tested with accuracy. He is unable to do the simplest calculation, his memory is very bad, mental reaction very slow, orientation in time and place very defective. He has a childish, fatuous expression, but his speech does not seem to be affected. There is no tremor of tongue or face. His mental condition suggests progressive dementia.

Case 16.—Preataxic condition, brisk knee-jerks, gastric crises, gradual development (with each successive crisis) of belt of thoracic anæsthesia.

F. B., aged 37; packer in tobacco. No neuropathic family history. Definite history of syphilis sixteen years ago with secondary symptoms, for which he was treated eighteen months; came to Charing Cross Hospital with paralysis of the right external rectus, Argyll-Robertson pupils, pains in the legs, first felt three years ago, history of several gastric crises, knee-jerks present and exaggerated, no Romberg symptom, no ataxy, no girdle sensation or difficulty with the bladder. Diagnosis, preataxic tabes. Eighteen months later, July, 1901, was seen again, suffering with pains in the legs. There was no change in his condition noticed. There is no squint now, the knee-jerks are still brisk, there is no trace of ataxy and no hypotonus. A little later, I found a patch of anæsthesia corresponding to the posterior branches of the fourth and fifth dorsal roots on the right side. The anæsthesia came on after a series of gastric crises, with local Three weeks later, he again suffered with a severe pains. attack of gastric crises, and on testing the cutaneous sensibility, I now found a complete belt of cutaneous anæsthesia corresponding to the fourth and fifth segments as shown in the accompanying chart (fig. 9).

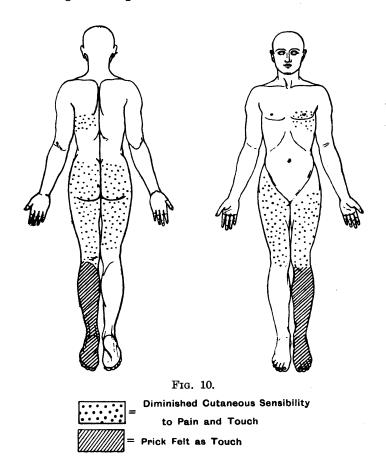


Case 17.—Tabo arthropathy. Gastric crises. Husband died in an asylum, of an acute brain disease, at the age of 36, very probably general paralysis.

B. C., aged 53, an inmate of Lewisham Infirmary, married at 17, no children born alive by the first husband; four menths after marriage, miscarriage; (2) miscarriage six to seven months; (3) miscarriage four months; she has always been in good health, she gives no sign or history of syphilis, except the history of miscarriages, and the existence of a pigmented scar, size of a half-crown, over the upper part of left buttock. Her husband died five years after marriage, at the age of 36, in an asylum, of acute brain paralysis. She remained a widow four years; married again, and had no children by her second husband.

Occupation.—After second husband died, she worked a heavy sewing machine for four years. She struck her knee against the wheel, and pain in the knee followed, but she had to go on work-

ing the machine to earn her living. The knee swelled up, but caused her no pain, she went to the hospital, and the surgeon informed her that it would have to be amputated, which surprised her very much. A year later, it was taken off at St. Thomas's owing to the foot beginning to swell. Mr. Shattuck has informed me that it was a Charcot joint. There were no signs of ataxy then. After leaving the hospital, she worked a hand machine for three



or four months, but she was obliged to give it up owing to attacks of sickness. These attacks came on independently of food. At the time she had her leg off, she had the Argyll-Robertson pupils, but no affection of the bladder or bowels.

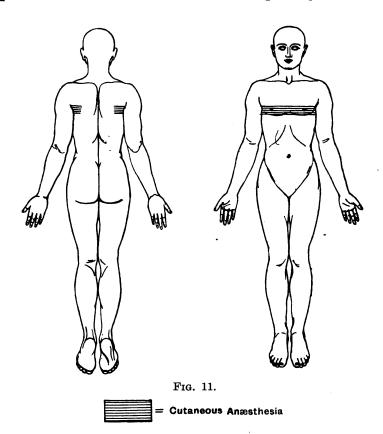
Physical condition.—Pupils unequal A.R. right 3 mm.; left 5 mm. Colour vision good. No contraction of fields. Reads small print. No affection of other special senses. Musculo cutaneous.

-Feeling of wool on the sole of the foot. Pins and needles of left hand. Marked loss of sense of position in joints of lower limb; not marked in hands. No great amount of muscular wasting, but marked hypotonus of left leg. Knee-jerks absent. For sensory disturbances of skin, vide charts. Visceral symptoms —She is subject to very severe gastric crises, which are preceded by intense occipital headache, and a feeling of distension of the stomach, and this is followed by attacks of lightning pain through the whole body; this pain does not however extend beyond the left knee, but into the stump of the right knee. It affects the left arm and fingers more than the right. The pain lasts from one to three days, and she is in the greatest agony. She gets no relief until she has taken a large dose or two of trional. She can't bear the light to the eyes, and has to lie on her face during the attack. She obtains no relief by hot bottles or fomentations. Swallowing ice gives some relief. She has on occasions vomited coffee ground matter, but never bright blood, and she has experienced relief afterwards. This was her own voluntary statement without the need of any questions being put. She has only one tooth in the upper jaw, and two in the lower. She tells me that they have all dropped out. Two years ago five dropped out in a very short time. Dr. Toogood (to whom I am indebted for this case) tells me that at various periods this patient has had patches of erythema in various parts of the body, following or associated with the crises. The complete loss of sensibility to all forms of painful stimulation in the left leg, coupled with the fact that this is the only part of the body in which she does not suffer pains during the crises, suggests the probability that the third, fourth, and fifth lumbar, and the first and second sacral roots are destroyed, and probably also the association neurons of the substantia gelatinosa in these segments.

Case 18.—Female. Definite syphilitic history, tabo-arthropathy, other symptoms of tabes slight. Cutaneous anæsthesia of fourth segment, but posterior divisions unaffected.

A. C., aged 57, married at 24, no children living, four pregnancies: (1) miscarriage six months after marriage; (2) born dead twelve months after marriage; (3) born dead; (4) miscarriage. Says that she had good health all the time, but hair came out soon after marriage; she suffered with sore throat and (rheumatic?) fever.

History of illness.—First symptom was a swelling of the left knee twelve years ago, came on gradually, very painful, she attributed it to kneeling as a charwoman. She went on using it to kneel on for eight years. For the last ten years she has suffered with pains in the legs. She had no ataxy. Two and a half years ago her left leg was amputated for Charcot's joint. A little later the right knee began to swell; it was very painful, and she had to come into the infirmary again. She complains now of pains in the hand, and she has marked ulnar deviation and typical rheumatoid arthritic affection of the phalangeal and meta-

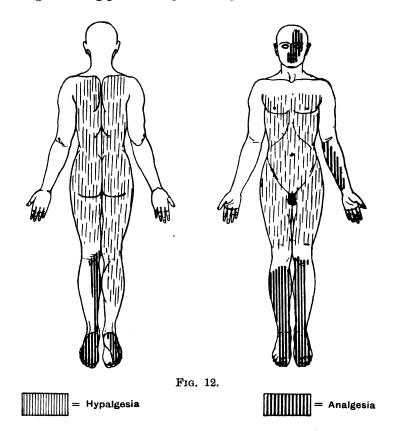


carpophalangeal joints. The deep reflexes, triceps and knee-jerks are absent. All the superficial reflexes are present. There are many papery scars over the back and legs; the right knee-joint is much enlarged, there is considerable fluid in the joint, and it is painful. She suffers with no ataxy of hands or feet, or loss of joint sensation. Cutaneous sensibility (see chart). Note pos-

terior division of fourth thoracic root not affected. Vision good, colour vision good. Three years ago she suffered with transitory diplopia. Pupils equal, 4 mm., A.R.

Case 19.—Ataxy, impotence with anæsthesia of genital organs and anal region, pointing to destruction of sacral and coccygeal roots.

R. D., aged 38, carpet planner, admitted for unsteadiness in walking, shooting pains in legs, and tightness round the waist.



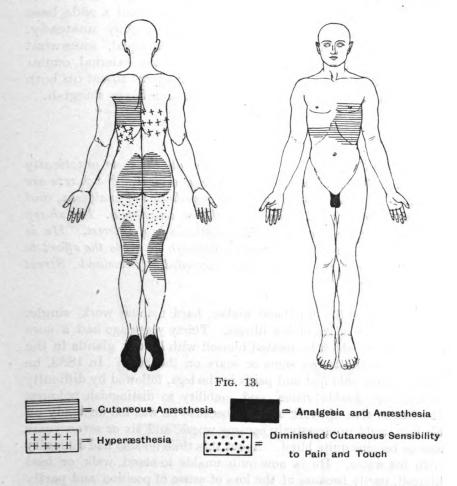
Family history.—nil noteworthy, no neuropathic heredity.

Personal history.—Married fifteen years. His wife has had nine children, six of whom are living.

Previous illnesses.—Syphilis two years before marriage, seventeen years ago suffered with hard chancre for which he was treated for two months. Patient has led a hard life, he has

been a carpet planner since he was twenty years of age. Moderate alcohol.

Present illness.—Began about a fortnight after recovery from influenza, January, 1900, by shooting pains in both legs and pain in the head of a morning. Between the attacks of pain he noticed numbness of the legs, and felt as if he were walking upon felt. He commenced to be unsteady in his gait, and frequently

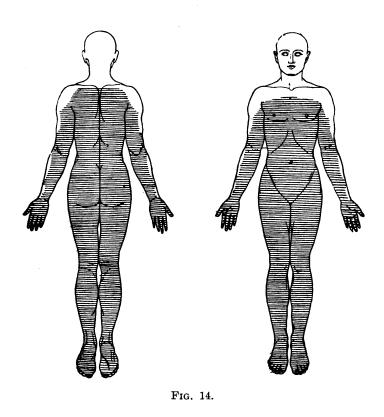


pitched forward as if his knees had given way. About this time he had very little power in retaining his urine, which would dribble away unless he frequently relieved his bladder. One month after the onset of the first symptoms, patient felt a numbness in the anal region, and he became very constipated; had also pain in the perinæum, especially when he micturated.

Feeling of constriction round the lower part of the abdomen for the last six years, not worse lately. Complete failure of sexual power for the last six months. No gastric, laryngeal, or nephritic crises. Muscular power unimpaired, some hypotonus of hamstring muscles. Sensation:—Considerable impairment of tactile and painful sensations in regions indicated in chart, but thermal sensibility unimpaired (figs. 12 and 13). Muscular sense Very slight incoordination of upper and lower unimpaired. extremities. Gait:—Patient walks steadily without a wide base of support, turns round fairly well, but slightly unsteady. Romberg's symptom fairly marked. Pupils equal, somewhat dilated, Argyll-Robertson. No paralysis of the external ocular muscles. Reflexes:-Knee-jerks and triceps jerks absent on both sides. Epigastric, cremasteric, and plantar reflexes sluggish.

Case 20.—Blind. Third stage of tabes, all the roots practically almost destroyed except the upper four cervical. The charts are interesting as showing the wider distribution of analgesia, and the more limited distribution of thermo-anæsthesia. The sharp line of demarcation of tactile anæsthesia is of interest. He is unable to converge the eyeballs, although he made the effort to do so and thought he had succeeded.—(Cleveland Street Infirmary.)

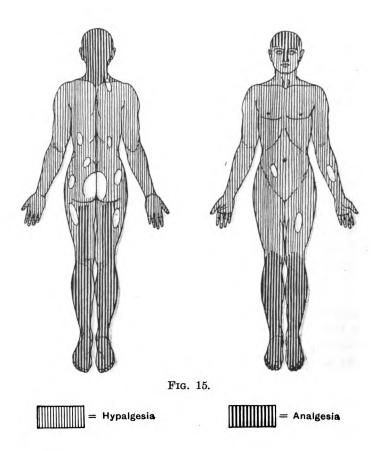
H. D., aged 50, mill band maker, hard manual work, single, does not know cause of his illness. Thirty years ago had a sore on the penis, which he treated himself with lotion; glands in the groin, hard shotty, no signs or scars on the body. In 1882, he suffered with cold feet and pains in the legs, followed by difficulty in walking, double vision, and inability to distinguish colours. He had to give up work in 1883, because he was too unsteady on his legs, sight progressively became worse, and six or seven years ago he became quite blind. About this time he also had difficulty with his water. He is now quite unable to stand, walk, or feed himself, partly because of the loss of sense of position and partly through muscular wasting and weakness. He is much emaciated, the feet are very cold and in a position of talipes equino varus; they are cyanosed, and the skin smooth and glossy. He is unable to turn himself over in bed, and is quite helpless. All the deep and superficial reflexes are lost in the limbs, and there is marked hypotonus. He has no joint sensations, and he cannot tell whether there is anything in his hands or not when it is put there, and the only way he knows is to put the object up to his lips and feel with this sensitive part of his body. Thus I put the percussion hammer in his hand, made him clench his fingers (he held it between the ring and middle fingers with the fist closed), but not till he had put his lips to it could he tell me that it had a stem. He is absolutely blind, right pupil 6 mm., left



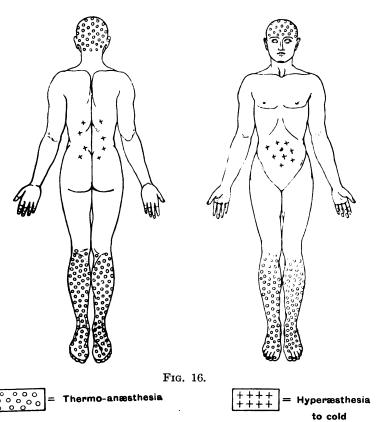
5 mm., cataract right eye, both pupils inactive to light and pain, and hardly any movement on convergence. On being told to lift up his left hand and look towards it, the right eye remains immobile. The left moved towards it, and then immediately swung back by oscillations to the straightforward position. The patient thought that he was directing his eyes to the hand all the

Cutaneous Anæsthesia

time he was making the effort to do so. He was unable to converge the eyes to the position required for looking at the nose, although he made the effort, and he was rather surprised when I told him that he had not moved his eyes. He has no affection of taste or smell; the cutaneous sensibility is indicated in the accompanying charts. It may be mentioned that there is always



considerable delay where sensation is felt at all, generally incorrect localisation, sometimes allochiria. There is a good deal of variation with regard to response to stimuli, as if the stimulus was sometimes insufficient to rise into consciousness, the stimulus sometimes became apparent by repetition and summation. Places where formerly he felt prick of pin were afterwards not felt, while other places were.



Case 21.—A case of tabes to show extension of anæsthesia over one side of thorax and down inner side of left arm, showing unequal affection of the roots on the two sides.—(Bethnal Green Infirmary).

E. M., aged 34, widow, charwoman. Married at 19, no children, never had any, history of three miscarriages, first being four or five months after marriage, marks of old syphilitic eruption on the body, and a squamous syphilide. Symptoms commenced two years ago with a giving way of legs, lightning pains and bladder trouble. She can walk fairly well, knee-jerks are absent even on reinforcement, there is considerable hypotonus in the thigh muscles, deep reflexes lost, superficial present. Pupils, irregular, slightly unequal, about 5 mm., very sluggish reaction to light, react well to pain and accommodation.

Cutaneous sensation.—There is anæsthesia and hypæsthesia over the left side of the thorax and extending down the inner side of the arm. There is a belt of cutaneous anæsthesia, as

shown in the diagram, and in this region there is hypalgesia. In the feet there is hypæsthesia and hypalgesia. Loss of joint sensation in toes.

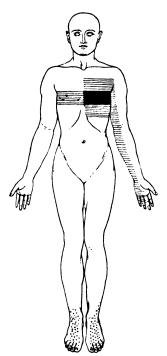


Fig. 17.

= Analgesia and Anæsthesia = Cutaneous Anæsthesia

| Diminished Cutaneous Sensibility to Pain and Touch

Case 22.—Female. History of syphilis from husband at 18; married second husband four years later, miscarriage, ulcerated legs, rectal crises, bladder troubles, and symptoms of mild gastric crises, loss of use of legs, symptoms of progressive tabes, marked cutaneous disturbances of trunk and lower limbs progressing rapidly with severe pains, loss of bone sensibility in same region as cutaneous disturbances. Mental depression, attempted suicide.

C. A., aged 37, married woman, went to the Obstetric Department of Charing Cross Hospital, and was sent on to me.

Personal history.—Married at 17 to a retired naval man; eight months' child born, lived only two days. She found that her husband suffered with venereal disease, she had a sore

throat and her hair came out; she therefore left him. After his death, she married again at 22 a retired soldier. Miscarriage four months after marriage, leaving her with uterine disease. Subsequently she suffered from ulcerated legs, and had two more miscarriages. She noticed first a feeling of a cord round the waist, then rectal crises, and difficulty in holding her water two years ago, for twelve months pains in the legs and body, and progressive difficulty in walking. Frequent attacks of giddiness and flatulent eructations with gastric distension.

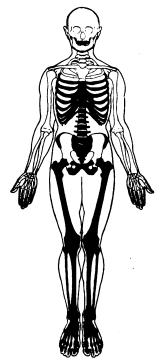


Fig. 18.

Black indicates the bones which are insensitive to the vibration of the tuning fork. The third and fourth ribs were not absolutely insensitive. In distribution the loss of bone sensibility in this case corresponded pretty closely with the cutaneous anæsthesia.

Physical signs.—Pupils equal, small, A.R.; absence of deep reflexes, plantar reflexes lost, epigastric just present, cutaneous anæsthesia from fourth to tenth segments inclusive, anæsthesia and paresthesia of soles of the feet, analgesia or hypalgesia to pricking of legs, and of the thorax from fifth to ninth segments, with some hyperæsthesia above and below. Marked incoordination and wasting of legs, no incoordination in hands. Marked hypotonus of hamstring muscles.

Two years later she became quite helpless, the cutaneous disturbances had become more marked. Slight contraction of field of vision, and pallor of discs. Retching attacks without vomiting, epigastric pain. Foot drop from paralysis of dorsal flexors, some inversion of soles, especially of right foot, from peroneal paresis. Loss of bone sensibility, as shown in the above chart. She is now very depressed because she fears she may give her husband the disease. She has attempted suicide.

Case 23.—Ataxy without anæsthesia, loss of sense of position, without loss of joint or bone sensibility.

H. M., aged 39. Occupation, warehouseman. Married, no children, one miscarriage three years ago. Contracted syphilis in 1886, treated for several months, well-marked secondary symptoms. No neuropathic or psychopathic history in family. For four or five years, suffered with pains in the legs. During past year has had difficulty in starting micturition, bladder not emptied. Difficulty of walking in the dark and sways with his eyes shut. For some time past has noticed that his legs would suddenly give way, feeling of constriction round the waist, shooting pains up the spine and down the legs, but never extending to the head. Gastric crises, attacks of palpitation, rectal crises, and laryngeal crises. While in the room he had an attack of laryngeal spasm and dyspnœa. Sight not so good as it was.

Physical examination—Deep reflexes lost. Ataxic gait first stage. Pupils unequal, A.B.; abdominal and plantar reflexes exaggerated. No cutaneous anæsthesia discovered, hyperalgesia over the thorax and in the legs. Bone sensibility unimpaired, joint sensibility unimpaired. Some general loss of weight. Hypotonus moderate of hamstrings, no muscular wasting. No foot-drop when lying on back. Considerable static ataxy in legs. Commencing grey atrophy of both discs.

GROUP 2.—Cases of Tabes with Insanity.

Case 24.—Tabes (? tabo-paralysis), with grandiose delusions, mania à potu, auditory hallucinations, analgesia. Tabic foot.

J. B., aged 38, admitted to Hanwell, April 2, 1900, occupation musician, single, duration of attack two weeks. He was admitted to the asylum in a very excited, restless, talkative, and threatening condition. He states that he is the greatest composer and flute player in the world. He fancies he has £80 in his pocket, which is not true, also that he possesses great wealth, horses, carriages,

&c. He talks incoherently of solicitors, detectives and numbers of police at his command. He has been employed in the orchestra of a theatre and he has led a very irregular dissolute life. Diagnosis was mania à potu and probably tabo-paralysis.

Personal history.—He has twice before suffered from melan-

cholia, the first attack occurring seventeen years ago.

Family history.—Mother died of phthisis, and father of paralysis, aged 61. Family history of intemperance. Patient's relatives very neurotic individuals (Dr. Alexander).

Medical examination.—Tongue coated, very unsteady, pupils equal and react to accommodation, not to light, knee-jerks absent,

history of syphilis with small scar on penis.

In August, 1900 when I saw him he was in the following condition :- Stepping gait, but can manage to get upstairs, absent knee-jerks, hypotonus in legs, Romberg's symptom. He has an enlargement of the tarsus on the right side. He is much quieter, mentally, than he was, sleeps well and is quiet and well-behaved. There is no tremor of tongue or lips, and no affection of speech is noticeable. Patient can give a good account of himself and his family, and his knowledge of time and place are alike good. The only evidence of insanity is a certain amount of loss of control and the repeated statement that he hears electric wires playing continuously. When questioned about this, he whistled an air from an opera to indicate the tune which the wires were playing. He was much astonished that I did not hear this music, but his listening attitude and expression convinced me that these auditory hallucinations were very real to the patient, and that what he was whistling was actually what he heard. In testing his sensation it was found that he did not feel the point of a needle except as a touch in any part of his body. After some delay he recognised a hot spoon. He has no girdle sensation and no visceral crises.

October 24. Further improvement, sent out on trial. He was not heard of again.

Case 25.—Tabes dorsalis, with ataxy and left crural monoparesis, auditory hallucinations, systematised delusions of persecution associated with the pains; little or no dementia.

F. W. R., male, aged 35, single, clerk; admitted to Claybury, September, 1899.

Family history.—Mother died in asylum, father attempted suicide, died of gangrene.

Personal history.—Gonorrhœa several times, syphilis at the age of 26, urethral chancre, followed by syphilitic eruption treated for

five months. Two years ago right great toe removed for diseased bone. He began to feel electricity in his legs about two years ago.

Mental state.—" Female enemies follow him about; they work the electricity on him; the whole thing is going on owing to a jealous woman, who has followed him from Plymouth to Homerton, thence to Claybury." He hears female voices talking every night; they talk to one another, and he gets quite confused and helpless; they are the voices of two nurses from Plymouth; he is watchful, and "has to keep his eyes open"; his memory and orientation are good, and he can talk on most matters quite sensibly.

Physical state.—On both shins numerous old circular punched out scars of former syphilitic ulcers; cervical glands shotty; pupils equal, 2½ mm., react slightly to accommodation, doubtfully to light. Knee-jerks absent; sensation is dulled and delayed in the feet and legs, but localisation fairly normal. Right mid-thigh measured 12 ins. in circumference, left, 113 ins. Right mid-calf is $8\frac{1}{4}$ ins. in circumference, the left, $7\frac{3}{4}$ ins. There is no loss of sense of position or cutaneous sensibility in the arms, but reaction time is lengthened. Plantar and abdominal reflexes present. He can hardly stand with his eyes open, and would fall when they are shut; his gait is tabetic; he stamps with the right foot when walking, and drags the left foot after him; there is hypotonus in both legs; there is some fine tremor of the tongue, but no jerking; there is no tremor of the face or lips, and no affection of speech. Later he developed a slight external squint in the right eye.

I saw this patient August 30, 1901. He walks with a wide base, heels down first, throws the right leg forward like a hemiplegic man, dragging the paretic left. He is unable to stand or walk without assistance; all superficial reflexes present; triceps and knee-jerk absent; sense of position lost in toes and ankle of right foot, not in left. Pupils, 3 mm., trace of light reaction in the right eye, none in the left; accommodation in both eyes. Cutaneous hypæsthesia in the area of the fifth thoracic segment; hypæsthesia and hypalgesia of the right foot, none in the left.

Mental state.—He answers questions quite rationally, but tells me that he hears voices at night talking to him; they are those of women, one particularly, a nurse, who continually annoys him, not only by what she says about him, but by causing him to have electric shocks in his limbs, body, and face. They pull his bowels about, and cause him to have pains at his heart; some time ago they continually put poison into his rice pudding, which burnt the

inside of his stomach. He has nothing to complain about his food now; his senses of smell and taste are both good (tested), also his hearing in both ears (tested).

April, 1902.—Physical condition shows little change, except that the general health is better. He is still very ataxic, and walks with a hemiplegic gait; his sensibility to light tactile sensations on the chest showed at first anæsthesia, but after repeated observations it became only a condition of hypesthesia of the sixth, fifth, fourth, third, and second dorsal root areas, the anæsthesia extending down inner side of the upper limbs as far as the middle of the forearm. The better appreciation of the cutaneous stimulus was no doubt an effect of summation. While performing this test his eyes were covered, and he was requested to put his finger on the spot touched. A metronome was beating at the time, and he said that he heard voices say to him, "You have been a lunatic to have gone away from Sydney Street." Last year he made the same statement when the metronome was set going, and he said it in rhythm. He hears the female voices especially at night, but also in the airing court, where they appear distant, but very real; when I spoke of them as hallucinations he was much disturbed. He has the same delusions that the people whose voices he hears torture him with electricity, and unasked he said "that they had now turned the electricity on to his arms," affecting his ring and little finger, which is of interest, seeing that the cutaneous anæsthesia has now spread to the arms, indicating thereby degeneration of the lowest cervical and uppermost dorsal roots. He says that "they pull his legs at night," which is, no doubt, an insane interpretation of spasmodic cramps; there is loss of joint sensation in the ankle and toes, specially in the right, by a failure of the synergic action of the dorsal flexors of the foot when the hip is flexed; considerable hypotonus in the legs; no affection of speech.

Case 26.—Early tabo-paralysis, (probably) drink. Delusion of wealth. Hallucinations and delusions respecting his wife who committed suicide.

S. J. P., aged 36, admitted to Hanwell, August 8, 1901. Occupation, coachman; married, no children.

Family history.—Father and mother died when young, no history of insanity or consumption obtainable. Brother and sister alive and well.

Personal history.—Since wife committed suicide eighteen

months ago, he has drunk a good deal. Up to then he had been quite healthy and temperate. About three months ago he suddenly developed ideas of wealth, and made all manner of statements with regard to the great deeds he had performed. He has always been good-tempered but excitable. chancre, treated at Lock Hospital four years before marriage. He has many delusions of wealth and grandeur; also that his wife has come to life again, persists that he saw her last Saturday week, and that she has been seduced by numbers of people. He knows where he is, the time of the year, and beyond the delusions mentioned, gives an accurate account of his previous life. Speech is unaffected, and there is no tremor in the lips or tongue. There is no ataxy, the right knee-jerk is absent, the left just obtainable. Pupils irregular, 3½ mm., Argyll-Robertson. No cutaneous anæsthesia.

He made the following statement to me:-

His wife came both to St. Pancras Infirmary and to Hanwell to see him, she was fairly well dressed, and looking well. She is now an actress at New York, but had never been an actress in England. She was buried from her own house, and he worried about her, and said he would have the coffin opened, and when they got there, they found the coffin empty. When she came to see him she had nothing on except a shirt, and a Mr. F. gave her clothes and took her straight out to New York. He has written a letter, but it has been returned. I asked him, "Did she talk to you when she visited you." He replied: "Yes. She said: 'We shall not have the old happy days over again,'" he said, "It was certainly not a dream."

April 1902.—Physical condition good, but he still persists that his wife is alive, and visits him occasionally, and that he knows she is not dead, for he had the coffin opened, and it was empty. He will talk quite rationally on other matters.

October 28.—Slight tremor of face and tongue, expression of early general paralysis. Slight dementia. He has now lost delusion about his wife.

- Case 27.—Tabes, optic atrophy, ataxy first stage, formication and sensation of water trickling in his skin, which he believes is the medicine he had at the London Hospital. Trunk anæsthesia and hypalgesia. Later crises either larnygeal or cardiac.
- J. D., married, aged 24. Denies ever having syphilis, but has been in the way of getting it, admits that he had a veneral sore, not treated. His wife has had four children born alive, of

which two are dead; one born dead, and three miscarriages. There is an inherited neuropathic history on the father's side. Patient himself has always been an anxious man; good husband, and good father, not addicted to alcoholic excess. He has complained for the last five years of rheumatic pains in his legs, and two months ago was unable to use his right arm on waking in the morning. He noticed that vision in his right eye was greatly impaired. For some time past his wife states, that he used to come home after his work greatly fatigued, and wanted to sleep. She never noticed any strangeness in his manner. He was always quite sane and rational, although very depressed. His wife noticed that he has had a staggering gait for more than six months past. Three weeks ago, he went to the London Hospital on account of his affection of sight. The curious sensory phenomena that he now complains of, he had then, and at first it was thought, specially as he had concentric limitation of the field of vision on the right side, that his disease was of hysterical nature. The Argyll-Robertson pupils, the gray atrophy, the absent knee-jerks and his mental depression led Dr. Head to consider the case to be either one of tabes with mental crises, or early tabetic general paralysis. He was sent to the Whitechapel Infirmary, and transferred to Claybury. He describes what took place when he appeared before the magistrates and was certified, and persists in the statement that he feels the sensations he described, that they are no delusions, and that owing to his having stated these sensations as being real, and due to the medicine he had given to him in the London Hospital, the magistrate was satisfied as to his insanity. He relates that another patient in the infirmary ward, told him that even if he felt those sensations he should not have mentioned them, but "he had to speak the truth." This morning, September 25, he said that he had the feeling of water trickling down his right leg, and a sensation as if his foot were swollen. He may have had this sensation; when, however, shown the right foot, and asked to compare the size and appearance with the left, in which he had the sensations described, he expressed himself as perfectly aware that his sight told him that there was no difference. He converses quite rationally on all subjects and displays no incoherence. His speech is not hesitant, nor is there any tremor in the tongue or lips. There is however, an expression denoting loss of tone in the muscles of the face, as if there were depression of the emotional centres. It may be, however, that this facial expression is partly due, as he says, to anxiety in being placed in

the asylum; his wife and children having no means of subsistence.

He also complains of this curious trickling (formication) coming up his back and over his head and to his forehead, but not on to his face; it travels also down his arms to the hands; he thought it was the medicine that he had in the London Hospital.

October 27, 1901.—Severe girdle sensations, which he describes as if something was squeezing him in a vice.

Patient looks well, good nutrition. He complains that he has had shooting pains in the upper part of the chest two or three months ago, but these have now passed off, and he now feels at night a sense of tightness and difficulty of breathing, with a feeling of soreness. It wakes him up with a struggle to breathe. It catches him in the throat. All over the whole head he has a feeling of tightness. When it comes upon him he feels as though thousands of needles were working upon him. He is obliged to take medicine to keep his bowels open. He complains also of burning feelings both in passing his water and motions. Passes his water pretty freely. No hallucination or delusions; recognised me perfectly. Has nothing to complain about food or treatment.

Speech is not affected. Sways a bit with his eyes shut. Can touch the tip of his nose with forefinger of both hands, has no ataxic gait. He says himself that he has a tendency to fall either one way or the other. Pupils equal, 4 mm., inactive to light, react to accommodation. Some limitation of the field of vision of the right eye in the upper and inner parts. Colour vision of the right eye somewhat considerably impaired, recognised yellow, not red, green or blue. Slight tremor of the tongue, slight tremor of the lips. He has rather a dull, heavy expression. There is a belt of cutaneous anæsthesia corresponding to the third, fourth, fifth, and sixth segments, with some hypalgesia in this region. On the feet and lower part of the legs and over the lower part of thorax and epigastric region there is some delay and hypæsthesia.

March 18, 1902.—The chart of the cutaneous anæsthesia has not appreciably altered. He still suffers with attacks of severe pain, which he says is like electricity; he also suffers with attacks resembling in some respects angina, which Dr. Jones says are of the nature of cardiac crises. The patient described the attacks to me as follows:—"He has always a feeling of a band around the chest, but at times it is as if it were being tightened up, making him unable to breathe, and necessitating him assuming a

sitting-up posture." The feeling of constriction, he says, spreads to his throat as if he were being choked (laryngeal crises?). This sensation is accompanied by severe pains shooting all over his body. He still has the feeling he described on admission as of a trickling of a fluid under his skin spreading up the back of his head over his forehead and on to his face. He believes that this feeling is associated with a swelling of the cheeks. Mentally he has not changed, there is no sign of dementia.

Case 28.—Tabes of sixteen years' duration, commencing with optic atrophy, followed soon after by mania with delusions of persecution; subsidence of acute mental symptoms and gradual development of spinal symptoms, which after ten years led to helpless ataxy, mental enfeeblement, but no progressive dementia. Death from acute dysentery. Tabic lesion of spinal cord and roots, in cervical and lumbo-sacral regions, especially; affection of both exogenous and endogenous posterior spinal systems; marked patchy pia-arachnoid thickening over prefrontal, frontal, and central convolutions; chronic atrophy of superficial layers of fibres and cells of cortex in these regions without vascular changes. Was this a case of mania and tabes, or tabetic general paralysis with arrest of mental symptoms?

C. R., aged 38, admitted to Colney Hatch in 1886 for mania and delusions of persecution. He had lost right eye when a youth as a result of injury. Some months before admission to asylum the sight in the left eye began to become dim, and he rapidly became completely blind. By occupation a colourman, the question of lead-poisoning was considered as a cause of his affection. There was no history of syphilis obtained, nor were there any signs on the body. The cause of the attack of mania was associated by his friends with the worry caused by the loss of sight. While in the asylum and after the subsidence of the attack of mania, ataxic symptoms developed, and in 1897 I first saw him in good physical condition, although he was in the third helpless stage of ataxy. He was unable to stand without assistance, and had to be supported by two attendants when he walked. All the deep reflexes were lost. The plantar reflexes were lost, the gluteal present on the right, absent on left, epigastric reflexes increased; cremasteric absent. The muscles are well developed, and the muscular strength is good; there is considerable hypotonus in hamstring muscles, the limb can he raised when extended at the knee to a right angle with the body.

Sensation.—He does not complain of pains, numbness, or formication. There is diminution of sensation and delay to all forms of stimulation, with very incorrect localisation in the feet and legs. Over the abdomen and thorax there is apparently some hyperæsthesia, especially to cold, but no anæsthesia or analgesia. He has no loss of sensation, painful or light tactile in the tips of the fingers, but there is a loss of sense of position in the joints. There is marked loss of sense of position of the joints of the lower extremities. The left pupil is dilated, and reacts neither to accommodation nor light. There is well-marked primary atrophy, with cupping of the disc.

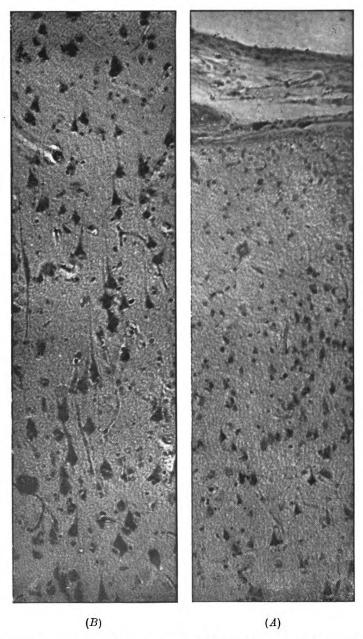
Visceral.—He is unable to retain his water which dribbles away from him; there is no history of gastric or other visceral trouble.

Mental.—He is somewhat weak-minded, but will converse about general topics, remembering the visits of his friends and what they said, and the day of the month. His comprehension is fair and he answers questions rationally; occasionally he is subject to violent outbursts of temper, but he has no delusions or hallucinations. There is continually twitching of the facial muscles and of the left orbicularis palpebrarum. He has no hesitancy or slurring of speech and the dementia has not been progressive.

The patient remained in statu quo until an outbreak of dysentery occurred in his ward; he was sick, took to his bed and passed a large quantity of blood and slime, became very anæmic and collapsed and died in two days. At the post mortem, I found the whole of the large bowel and the lower twelve inches of the small bowel filled with blood and slime; there was no ulceration anywhere in the alimentary canal to account for this; the mucosa and sub-mucosa were greatly swollen and congested and, microscopically examined, showed the characteristics of the very acute fatal form of dysentery. The other thoracic and abdominal organs were healthy with the exception of some atheroma of the aorta. The brain weighed 46 ozs., there was not much sub-arachnoid fluid, but there was considerable pia-arachnoid thickening over the frontal and central convolutions on both sides. There was especially thickening of the membranes and atrophy of the superior parietal lobe, just behind the upper fourth of the ascending parietal, and on stripping the membranes, a shallow pit, 1 in. square was seen, due to this atrophy, symmetrical in both hemispheres. The lateral ventricles are faintly granular and not dilated; the fourth ventricle is somewhat dilated and



PLATE I.

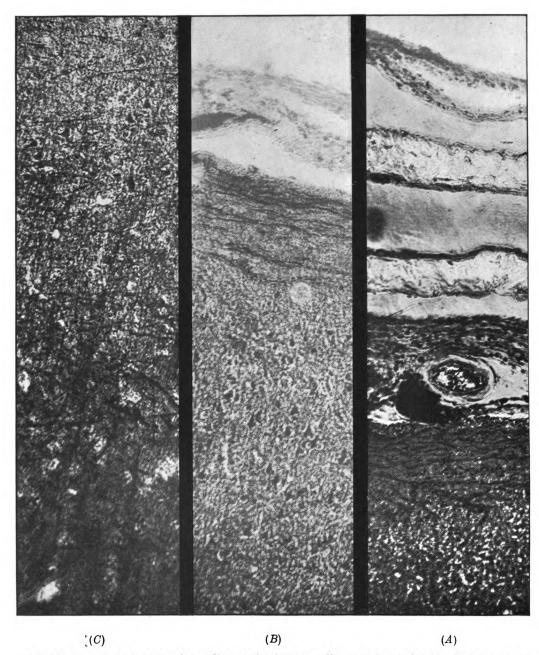


Section of superficial layers of ascending frontal, showing (A) Molecular layer and small pyramids; (B) medium sized pyramids. Magnification 180 diameters.

TABES IN ASYLUM AND HOSPITAL PRACTICE.

To face p. 125.





(A) Thick section of cortex (ascending parietal) with adherent pia-arachnoid which is greatly thickened, and consisting in this situation of a series of strata of dense fibro-vascular tissue. The tangential and supraradial fibres in the subjacent cortex are diminished considerably, but the section is too dense to show this properly.

(B) Thinner section of cortex (ascending frontal). Membranes not so much thickened, a fair number of tangential fibres seen.

(C) Deeper layers of cortex (ascending parietal) showing radial, supraradial, and interradial fibres.

Magnification 150 diameters

Magnification 150 diameters.

there are some granulations. There is slight thickening of the piaarachnoid over the superior temporal convolutions and along the tip of the temporal lobe, and the anterior part of the uncinate convolutions. The thickening of the membranes and atrophy of the convolutions is more apparent in the upper two-thirds than the lower third of the central convolutions.

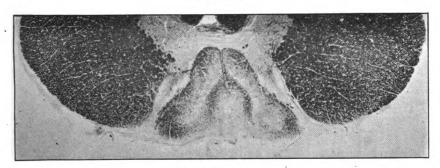
Preliminary microscopic examination of the brain by Nissl and Weigert methods of staining cells and fibres showed the following conditions:—The small cells of the molecular layer of Cajal are greatly diminished in places; also, but to a less degree the small pyramids, and less still the medium sized pyramids. Those cells that remain of the pyramidal layers have a fairly normal appearance and are arranged in columns with straight apical processes which can be followed for some distance. The large Betz cells lying in small groups of four to six are for the most part quite normal, they have all their processes, and the majority of cells present no chromophilous changes. Portions of the first frontal, ascending frontal, and ascending parietal, stained by Wolter's method for fibres show thickening of the pia-arachnoid of considerable degree and proportional to an atrophy of the tangential and supra radial and interradial fibres, quite as marked as in a case of fairly advanced general paralysis. There are no vascular changes, no plasma cells, and comparatively little glia cell proliferation (vide photo-micrographs, Plates I. and II.) The complete examination of this brain will occupy the subject of a future communication, being one of considerable interest. Is this a wasting of physiologically correlated structures in a case of tabes, or is it the lesion of a case of arrested general paralysis? When such difficulties of diagnosis exist, as in this case, one is impressed by the unity of the two diseases.

Microscopical examination of the spinal cord.—The degeneration in the spinal cord corresponded fairly accurately with the clinical symptoms observed during life. The cord was, with the exception of the posterior columns, of normal size, the myelin sheaths, unlike many tabo-paralytic cases, stained remarkably well. There was no degeneration of the pyramidal systems of fibres to be found anywhere. The atrophy was limited to the posterior roots and posterior columns of the cord. There is almost complete disappearance of the fibres of lumbo-sacral roots forming the cauda equina. The upper four lumbar and the last four dorsal roots at attachment to the cord possess still a large number of healthy fibres; in the mid and upper dorsal roots the fibres become less and less numerous until the cervical region is reached. At the

seventh cervical there is a great increase in the number of fibres, and above this level the number is normal, and there is abundance of fibres in the cornu radicular zone.

Spinal cord.—The column of Goll is completely denuded of fibres in the cervical region, except a A shaped portion in front, which corresponds to the lower dorsal and upper lumbar roots; in front of this area of fibres there is a Λ shaped area of sclerosis which corresponds to the outfall of fibres in the upper dorsal and lowest cervical roots. Examination of each segment of the cord shows that this most ventrally placed Λ shaped area of sclerosis corresponds to the outfall of fibres coming from the upper three dorsal and last cervical roots. These represent fibres which carry impulses from the deep structures, muscles, and joints of the hand. Thus at the eighth cervical we find a complete atrophy of entering root-fibres. The A shaped area of healthy fibres between the two areas of sclerosis are partly descending endogenous fibres, for fibres can be seen passing obliquely from the cornu commissural zone into this area, forming below the comma shaped tract. A good number of the fibres may, however, represent long fibres from roots of the lowest dorsal and upper lumbar, seeing that the clinical signs and microscopical examination showed these roots were not much affected. lumbo-sacral region there is much shrinking of the posterior columns; the only fibres that exist are the endogenous occupying the cornu-commissural zone, oval area, septo-marginal and Gombault's triangle, but the fibres in these tracts appear very much diminished. The fibres which are most atrophied are those forming Goll's column (long fibres), cerebral, and those concerned with reflex spinal tonus, viz., those occupying Charcot's root zone. These two sets of fibres seem very completely atrophied. The fibres which enter the column of Clarke as soon as it appears at the level of the second lumbar segment, are not completely destroyed; some fibres can still be seen entering the column at different levels, and breaking up into a plexus around the cells; still there is very considerable atrophy of this plexus (examination of the photomicrographs of Plate III. will enable the reader to follow the above description of the changes in the spinal cord). Lissauer's tract is not so markedly atrophied even in the lumbo-sacral region. This may account for the fact that the cutaneous sensory disturbances were in proportion to the marked ataxy and helplessness, but slight comparatively. slow progress of the disease may be connected with the blindness from optic atrophy. Examination by Nissl's method showed that

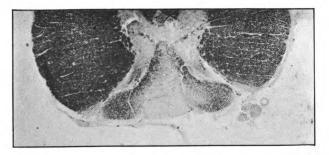
PLATE III.



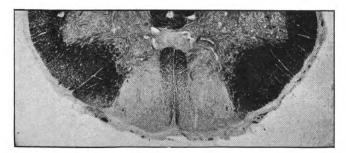
Fourth Cervical.



Eighth Cervical.



Tenth Dorsal.



Fifth Lumbar.

Tabes in Asylum and Hospital Practice.

To face p. 126.

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the spinal motor cells were normal in appearance, the granules of Nissl were normal in the cytoplasm and on the processes. This agrees with the fact that there was not very marked hyptonus, and the muscles were of good colour and in no degree wasted. There was an abundance of small association and sensory cells of normal appearance in the anterior and posterior horns.

Case 29.—Advanced tabes (which commenced with gastric crises at 17?), ataxy and double vision at 28. At 39 admitted to asylum for an attack of mania with visual hallucinations and delusions.

A. R., aged 39, general servant. No history or signs of specific disease. She says she had rheumatic fever at 17 (?) No history of ulcers on the eyes. Just after age of 17 she had attacks of vomiting, which would come on without any food in the stomach. Mother died of consumption; father of senile decay; nine brothers and sisters, of whom seven are alive. At the age of 26 she commenced to have shooting pains in the legs. Could not walk about in the dusk without tottering, and used to totter when she washed her face. At 29 she had double vision, and saw Mr. Nettleship, at Moorfields. He said that there was loss of sense of position in the feet; she was taken into St. Thomas's Hospital under his care. She had drooping of the right eye, and was treated with blisters round the forehead. She went out and took a situation, but found that her right leg used to give way from time to time; she still had gastric crises; gradually walking became more difficult, and a stamping gait developed. She went into Highgate Infirmary incapacitated; gradually legs became more helpless, and the vomiting became very severe. The vomiting has ceased for the last two years, but she still has the girdle and lightning pains, but not nearly so badas before. She has not full control over the bladder, fairly good control over the bowels, but cannot wait for either micturition or She had been suffering from irregular catamenia, which sometimes was suppressed for a year; this came on before the diplopia. Had complete loss of power in the legs for six years. Prior to this there were spontaneous unconscious irregular jerky movements when she was in bed. She also had irregular jerky movements in the hand, in attacks resembling St. Vitus' dance. Had pins and needles in the fingers (paræsthesia).

In August, 1899, she suddenly lost herself, and developed a shakiness in the hands; she spilt her food owing to choreiform spasm. She lost consciousness, and had visual hallucinations.

She thought she saw the matron making preparations to burn her up, and this became a fixed idea for a short time. She did not remember her relatives when they came to see her. Delusions that she was being tried by a judge and jury for some supposed crime. She had the delusion that her brother had been killed in trying to assist her. She was transferred to an asylum at the end of October. When, however, she was admitted to Colney Hatch, there was but little mental affection. The nurse says she has had no delusions or hallucinations. She now seemed very intelligent, and gives a most intelligent history of her illness.

Condition on admission.—Loss of sense of position in both hands. Cannot touch nose with fingers when the eyes are shut. No affection of speech; hearing normal. Legs extended in bed, feet inverted and flexed at the ankle, the knees extended. Complete paralysis of the feet and legs; she is unable to move any of the joints of the foot or leg, and cannot move her hips. There is marked foot drop and inversion of the feet. Knee-jerks absent on both sides; the muscles are wasted, but how far this is due to prolonged disuse I cannot say. Plantar reflexes gone, epigastric reflexes brisk. Great weakness in muscles of back and neck, causing a certain amount of lordosis. She has to jerk her head to get it erect. All the muscles respond normally to the faradic current. No tenderness on percussion over her spine. Right disc indistinct, and smaller than natural. Pupils, 6 mm., react to accommodation, but not to light. The sensory charts made in this case exhibited very marked cutaneous sensory disturbances to touch, pain, and heat and cold, in the regions supplied by the roots of the third to the tenth thoracic, and from the fourth lumbar to the last coccygeal. There is delay and diminution of cutaneous sensibility of a partial character in the areas supplied by intervening roots, and above the complete anæsthesia of the trunk there is hypæsthesia of the skin of the arms and of the trunk as high as the second intercostal. All the roots, therefore, below the third or fourth cervical are affected, and one would expect to find complete denudation of fibres in the roots, corresponding to the areas of complete anæsthesia, accounting in a measure for the complete loss of power in the lower extremities.

Case 30.—Tabes, married woman, syphilitic history, mental crises in the form of hallucinations and delusions, Charcot's joint, gastric crises, preceded by pains in the swollen knee-joint.

E. C., aged 39, married woman admitted to Banstead, August, 1898, with acute mania. hallucinations and delusions. There was

a history of six miscarriages and no children, but no history of insanity or nervous disease in the family. There are scars of old syphilitic ulcers on the legs. The symptoms of tabes commenced at the age of 33 with lightning pains, for which she attended St. Thomas's Hospital. When she was 36 years of age she fell down stairs, her right knee swelled up, and she was delirious. She was taken to St. Thomas's Hospital, but was a week later transferred to the Lambeth Infirmary on account of hallucinations and delusions. "Men with monkey's skins came and stole her things out of the drawers." It was real to her then, but she now knows it was only a delusion. Once only while she has been at Banstead (two years), has she had any real mental disturbance. She was, according to the nurse, delirious and had visual hallucinations: she saw her husband and friends at her bedside, and wanted to get out of bed and go with them. She suffers with severe attacks of gastric crises at times, which last for several days. The crises seem to be preceded by pains in the right swollen and diseased knee-joint. Over the external and internal condyles there is a sinus, from which pus is constantly discharging. joint is nearly 20 ins. in circumference and disorganised. The muscles of the leg are greatly wasted, and there is well marked foot drop. The patient states very definitely that during the gastric crises lightning pains radiate all over the body, passing down the legs and arms, up the back, and terminating in the forehead, but never spreading to the face. The knee-jerk in the left leg is absent; there is hypotonus of the hamstring muscles, and a marked loss of joint sensibility in the lower limbs. Robertson pupils. There is no loss of tactile or painful sensibility in the upper limbs, but slight incoordination and loss of sense of position. Painful and light tactile sensation is lost or impaired below the knee, and there is slight blunting or loss of light tactile sensibility in the area corresponding to the sixth, seventh and eighth segments. There is no bladder or rectal trouble. The patient was sent to St. Bartholomew's, and the right leg amputated above the diseased joint, which was sent to me for examination, by the kindness of Dr. Claye Shaw and Mr. Walsham.

Examination of the nerves of this joint showed atrophic degeneration somewhat similar to that which is found in the posterior root of an ataxic case, viz., disappearance of myelin from sheath, proliferation of nuclei of primitive sheath. This, of course, may be simply a disuse atrophy associated with prolonged immobility, or it might be explained by damage of the nerves from the dead bone and discharging sinus.

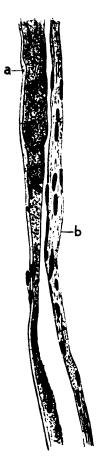


Fig. 19.

Teased nerve-fibres entering the peroneus longus muscle away from any obvious septic inflammation. At (a) the myelin is shown filling the neurilemma; it has an opaque dull appearance, indicating a congulation neurosis. At those portions of the fibre where the myelin has disappeared the nuclei have undergone proliferation; (b) is a fibre in which the myelin has quite disappeared. Staining, alum hæmatoxylin, mounted in ammonium picrate and glycerine. Magnification 450 diameters.

GROUP 3.—Tabo-Paralysis.

Case 31.—Onset with fits, headache, loss of memory, insomnia; admitted to asylum with symptoms of acute mania and physical signs of tabes. Subsidence of mania, marked ataxy, convulsive seizures, gastric crises, shooting pains with associated delusions, lucid intervals, but a progressive mental enfeeblement. Death.

I. D., female, aged 31, single. Occupation, colour printer. Admitted to Cane Hill on October 2, 1897.

History.—No family history of insanity or phthisis. She attended a dispensary about seven months for some disease of the genito-urinary organs, but whether this was syphilis cannot be definitely ascertained. She had two fits five months ago, and for the last three months she has had headache, loss of sleep, and failure of memory. Quite recently her speech changed, and she became very restless and talked incessantly. The cause of the attack is stated to be disappointment in love.

On admission.—A young woman, thin and badly nourished, but with no signs of organic disease of viscera. Tongue clean, pupils equal and contracted. No reaction to light or accommodation. Knee-jerks absent. She has general movement of head and arms. Waves her arms continually and moves her head about in all directions. The movements of her arms are purposeful. She undoes her hair and does it up again continually, and keeps unbuttoning her dress. Her gait is unsteady and ataxic. She is destructive and very mischievous. Is wet and dirty in her habits. Will not keep in bed, but rolls off on to the floor. Mentally she is in a condition of acute mania. Is very restless and resistive to everything. Unable to answer the simplest questions properly, but rambles off irrelevantly. Childish and foolish. Memory bad.

November 2.—Symptoms of mania persist; she has required sedatives (such as chloral and paraldehyde) on account of her extreme restlessness. Still wet and dirty and very destructive.

December 1, 1897.—She has become much clearer mentally. The attack of mania has subsided. She is fatter and stronger, and the movements have entirely ceased. She now has well-marked signs of tabes dorsalis. Ataxic gait and loss of knee-jerks. Pinpoint pupils, slight reaction to accommodation, but not to light. Has anæsthesia of the ring and little fingers on both sides.

January 2, 1898.—She has lately been having attacks of vomiting, and has complained of pains in her abdomen and legs. Is very shaky and ataxic, and is becoming very feeble. To-day, she had a convulsive seizure, and became comatose for some time. Her face has lately become greasy and expressionless.

March 1, 1898.—She has been practically bedridden since last note. Quite helpless and feeble, and has become wet and dirty in her habits again. Often vomits and complains of pain round her waist. Her speech is now slurred, and her tongue tremulous, and she is more demented. Her condition now differs in no way from the last stage of general paralysis.

April 14, 1898.—Still bed-ridden and extremely feeble and

helpless. Has become very rigid in muscles of neck and limbs. Is quite demented and cannot understand or answer the simplest questions. Has paresis of left internal rectus. Occasional pyrexia. Her right pupil is now slightly larger than the left, but there is no reaction to light.

May 18, 1898.—Still in bed. General rigidity of muscles all over body. Wet continually. No vomiting now. She improved in mental condition, and was able to get up and sew a little, and take a fairly bright and intelligent interest in her surroundings; but in the middle of July, she became very restless and excited, refusing to stay in bed because she said mice ran over her body and pillow. She makes frequent attempts to catch them. Continual use of sedatives necessary on account of her restless condition. She complains of the treatment by the nurses, that they had put something chopped up in her milk, that they had scraped her bowels out and spoiled her features. This was no doubt an insane interpretation of the gastric crises. (F. W. M.).

August 12, 1898 (F. W. M.).—The patient says she is feeling much better. The nurse says she is quiet now, but she has been very excited and troublesome. There is typical ataxy of the lower limbs. The knee-jerks are absent and she is unable to stand or walk alone. When supported by two nurses she can stand with difficulty, but on closing the eyes she would fall if not supported. She can touch the tip of her nose with her finger, and she can write her name, but there is a good deal of fine tremor in the strokes. She complains of sharp shooting pains in the legs and round the stomach. She passes water involuntarily. but has control over the bowels. She has not menstruated since she has been in the asylum. She has lately had an ulcer on the cornea. Pupils, Argyll-Robertson, small, equal. There are no synæchiæ, and the fundi are normal. She complains of a feeling like wool on the soles of her feet, and she is unable to say what is being done to her great toe when it is flexed or extended. There is some loss of painful and tactile sensibility in the lower limbs. There is no tremor of the face or tongue. There is slight ptosis of the right eye-lid. Smell and taste are good, also hear-Speech normal.

Mental condition.—She appears to me quite rational, but her memory is somewhat defective. She told the nurse that she had a baby at Liverpool, and that she has had two abortions. She tells me the same story, and that she has lived with several men. Some time ago she had delusions that there were mice in the bed. When I last saw her she was in an unconscious state, and I

judged that she was suffering from a congestive seizure of general paralysis. (F. W. M.)

June 19, 1899.—Mentally the patient has greatly improved since I last saw her. She talks quite rationally, has no loss of knowledge of time or place, her speech is unaffected. She tells me that she has had many attacks of vomiting lately, and diarrhea. She complains also of a tight feeling in her left side (gastric crises). She also tells me that she has a feeling of wool on the soles of her feet. There is considerable blunting of sensation in the lower extremities, especially on the left side. She feels sharp pricking, but there is considerable delay, and blunting of sensation. There is no incoordination in the hands now. She can knit and sew. Complains of dimness of vision in the left eye.

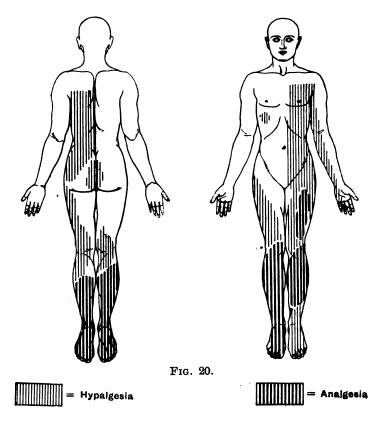
October, 1899.—The patient has been free from mental symptoms for the last six months, and she talks in a perfectly rational manner, without any hesitation or slurring of speech. She complains of a girdle sensation round the waist, and for the last three months she has suffered from severe attacks of vomiting and nausea. She has had shooting pains in the legs, is constipated, and wets the bed at night; she has had no more fits. There is considerable incoordination in the hands, and she is unable to sew as well as when I last saw her; she has numbness of the ring and little fingers of the left hand.

October 9, 1900.—Patient is in a fairly rational condition of mind, and able to answer questions. She knew me quite well. She has had many attacks of vomiting since I saw her, with shooting pains in the left side and legs. She has attacks of pain in her legs nearly every day. The attendant informs me that not long ago she became very restless and violent, and very difficult to manage. She believed that she was going to marry Dr. B., and wrote numerous letters on the subject asking him to provide clothing for her. She tried to tear out all her gray hairs, and wished to have all her teeth drawn in order that she might be made beautiful and captivate the doctor. She was very destructive, tearing up her clothes. She remained in this maniacal state for over a month. When she had fits she would lose consciousness, sometimes for four hours together; the convulsions were mostly on the left side.

Physical examination.—The limbs are well nourished, but there is very marked hypotonus in the hamstring muscles. The extended limbs can be bent to an angle of 75° with the body. There is loss of sense of position in the hands. Sensation, tactile, absent in the shaded parts of the diagram, although there are

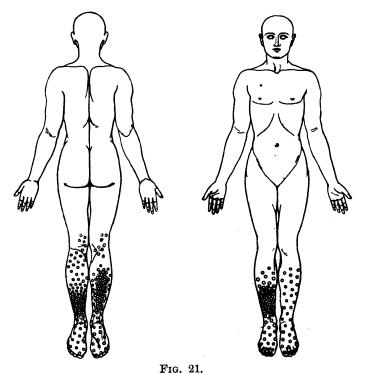
scattered patches of normal sensation with a delay in response, tested by lightly touching with the finger. Painful sensation, pricking with a needle; result shown in the accompanying diagram, likewise thermal sensation. In parts of the body other than those indicated in the diagram she always gave a correct answer, showing that she was able to appreciate and respond to the stimulus.

July, 1901.—Smell and taste.—She cannot smell peppermint, assafætida, or rose-water. She can taste quinine, but syrup and acids are not appreciated. Hearing.—Hears a watch 18 inches



on either side. Colour vision.—Picks up correctly colours with one eye closed, but marked incoordination and failure of judgment of distance noticed. Pupils.—Right 3 mm., left $2\frac{1}{2}$ mm.; inactive to light, very sluggish to accommodation, outline irregular. She takes her food, but is much weaker than she was; she has had no fits lately and no sickness. Tongue and lips tremulous, but the speech is not affected. She has no control

over the sphincters, and when she wets the bed she says that some one else has done it. Although so emaciated, she has a ravenous appetite. After she has eaten her dinner, she fancies that some one else has had it, and she will steal another patient's dinner if she is not looked after. She is quarrelsome, and will smack the faces of patients who sit next to her. She forgets the incident the next minute. She forgets the names of people, but she has not personal illusions. She has not complained of bad tastes in the mouth or bad smells, nor has she now any delusions



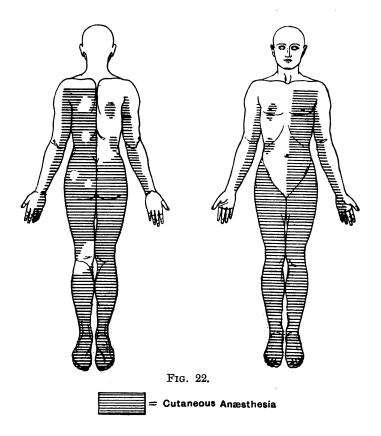
Thermo-anæsthesia

of poisoning. She recognised her friends, but her knowledge of time and place are extremely defective. She does not know whether it is winter or summer, morning or afternoon. I told her that she had had her dinner, she then replied that it must be afternoon.

January, 1902.—Death from pneumonia.

Autopsy.—Broncho-pneumonia affecting the right lung especially. Nothing especially noteworthy in the other organs, except

the ovaries; the left Fallopian tube is matted to the ovary and uterus, and exhibits the appearance of old non-tubercular salpingitis. There were no signs of syphilis on the body, but the vagina was large, and this, together with the absence of hymen, a scar on the cervix and the condition of the Fallopian tube mentioned, accords well with her statement of abortions and the history of some venereal infection. Brain.—No adhesions of the dura mater, slight excess of sub-arachnoid fluid, slight thickening



and opalescence of pia-arachnoid over the frontal and central convolutions. Some adhesions along mesial surface of frontal lobes, very little wasting or thickening of membranes of pre-frontal or orbital lobes. Some wasting of first, second, and third frontal at junction with anterior frontal; no obvious wasting of Broca's convolution; optic nerves small, but not gray. Olfactory nerves small, membranes thickened, opalescent, and adherent about the tip of the temporal lobes and origin of olfactory. Granulation of

lateral ventricles, but very little dilatation. Marked granulation and some dilatation of the fourth ventricle; erosions of central convolutions on stripping the membranes, decided atrophy of upper two-thirds of central convolutions on both sides. Naked eye atrophy and gray degeneration of the posterior roots and posterior columns of the spinal cord.

Microscopical examination.—Teased preparations of posterior roots exhibited a large number of empty sheaths with proliferated neurilemmal cells; others, the myelin sheath partially gone, or irregularly disposed—indicating a regressive atrophy. There are comparatively few healthy medullated fibres to be found in the posterior roots of the regions of the cord, where there is usually atrophy.

The degeneration of the spinal cord was the same in character as met with in ordinary tabes; its distribution is shown in the accompanying chart, to which attention is called, as to the following facts. There is a very complete degeneration of the posterior roots in the upper nine dorsal segments, and a corresponding extensive degeneration in the postero-external columns; it will be observed that at the fifth dorsal segment, there is a marked atrophy. of the posterior horn, and an indentation in this region on one side. In the lumbo-sacral region there is also complete degeneration of the posterior roots, and the roots of the cauda equina. Although the endogenous systems do not present the same degree of degeneration as the exogenous, it will nevertheless be observed that the chart indicates, especially in the dorsal and lumbo-sacral regions, a considerable destruction of the fibres arising from the cordonal cells, and no doubt this fact indicates more advanced degeneration, and explains the marked ataxy of the lower limbs from the very commencement and the only slight incoordination of the upper limbs, for the case shows that she was able to knit and sew.

The distribution of the degeneration accords fairly well with the chart (fig. 23), indicating the distribution of anæsthesia and analgesia observed during life, six months before she died. Probably the roots on the right side were subsequently affected, for the roots in the dorsal, lower lumbar and sacral regions were practically denuded of fibres on both sides.

The whole cord was not larger than that of a child of two years, particularly is this noticeable in the dorsal region. Another fact indicating a metabolic change was the difficulty with which the myelin sheaths of the nerves stained, resembling in this respect the cords of new born children. Owing to the extreme atrophy of the posterior roots, therefore, of the projections in the

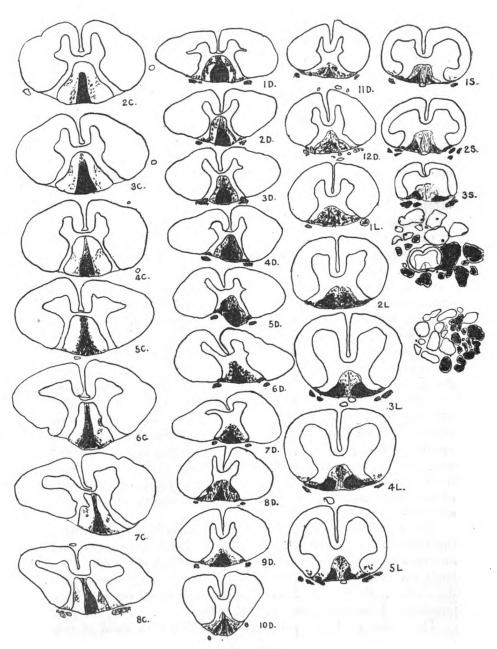


Fig. 23.

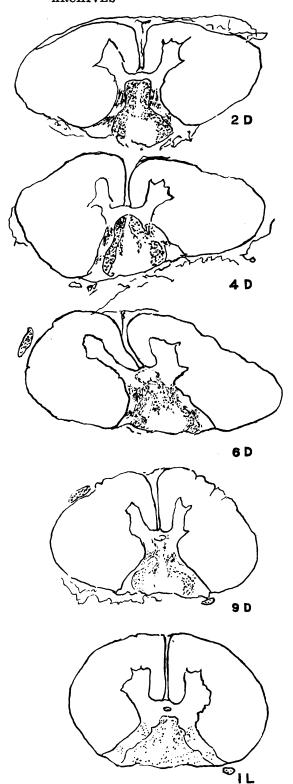
Diagram made with Edinger's projection apparatus, from sections of the spinal cord stained by Weigert-Pal method. Complete degeneration and atrophy of fibres is indicated black, partial atrophy by black dots.

cord, the course of endogenous fibres still existent could easily be followed and the following notes were made (vide fig. 24):—

Cauda equina.—Complete degeneration of all the fibres of the posterior roots, with imperfect staining of fibres of anterior roots. A section of the fourth sacral segment roots included showed a small triangle of fibres in the posterior column, endogenous, and corresponding to the posterior median triangle of Gombault and Philippe. This tract of fibres is continuous with a tract which lies along the median fissure in the first, second, and third sacral segments; at the fifth lumbar segment, there are no root-fibres, and these septo-marginal fibres can be traced along the posterior column to the posterior horn, while other fibres can be traced from the cornu commissural zone to the base of the posterior horn. The septo-marginal tract is seen to be continuous with the oval area of Flechsig, so that we may consider these three tracts with separate names are merely divisions of the same system of endogenous fibres. At the level of the first lumbar and last dorsal, at the very extremity of the posterior median fissure, there exists a small triangle containing still a number of undegenerated fibres. This tract of fibres is continuous below with the oval area. of Flechsig, and above with the internal zone, which consists in a great measure of descending endogenous fibres; it is is continuous above in the upper dorsal region with the comma shaped tract. Study of the sections shows that a large number of reflex collaterals are given off by these endogenous systems and that they consist of two sets of fibres, ascending and descending. The comma tract, posterior internal triangle, fibres continuous from there along to the median fissure which form the septo-marginal tract, oval area of Flechsig and the posterior triangle of Philippe constitute the latter. Collaterals are given off all the way down in two situations: (1) in the substantia gelatinosa, where the fine fibres of Lissauer's zone end; (2) in the posterior horn opposite the root zone. The ascending endogenous system forms the cornu commissural zone of Westphal; the fibres from this zone in the dorsal region can be seen very distinctly running forwards in three groups of fibres: (a) External to Clarke's column; (b) Internal to Clarke's column, to form a plexus at the junction of the anterior and posterior horns; (c) Fibres decussating in the posterior commissure from the other side (vide fig. 27). These fibres can be distinctly traced, owing to the complete atrophy of the collaterals of the exogenous fibres around the cells of Clarke's column; the fibres from the latter entering the direct cerebellar tract can also be seen distinctly as they pass outwards and upwards across the base of



Outline drawing of spinal segments, showing fibres of endogenous origin remaining in posterior columns of spinal cord at levels where there was complete degenerative atrophy of the roots 2 D, 4 D, 6 D, and those intervening; also nearly complete atrophy at lower levels in the dorsal region. The fibres form the comma tract of Max Schultze. They give off collaterals at different levels to the gray matter of the posterior horn, some of which decussate in the posterior commissure. They probably keep entering and leaving the white matter at different levels. At various levels they pass backwards to enter into the formation of the posterior internal triangle. At the first lumbar they leave this position to form the septo-marginal tract.



the column. Although these endogenous fibres can be distinctly seen owing to the complete atrophy of the exogenous systems, yet, as the chart shows there is a great outfall of these fibres in the whole of the dorsal and lumbo-sacral regions, the descending system being more affected than the ascending. Briefly, the degeneration corresponds with the advanced second stage or commencing third stage of ataxy, and the marked atrophy of roots in the upper dorsal and lumbo-sacral regions corresponds with the anæsthesia and analgesia observed during life, more marked on one side than the other.

The degeneration of roots and posterior columns in the eighth cervical and first dorsal, more marked on one side than the other, corresponds with the more marked sensory disturbance (observed during life) on the left than the right side.

The fact of the existence of the gastric crises may be associated with the marked degeneration of the roots in the mid dorsal region, and especially with the obvious affection of the gray matter in the fifth and sixth segments. It will be observed that there was no direct or crossed pyramidal degeneration, except possibly in the lowest lumbar and sacral regions, and this would accord with the fact that there was little chromophilous change in the Betts' cells of the cerebral cortex.

Brain.—Examination by cell and fibre methods. There is very little vascular change in the cortex as a rule, but typical plasma cells were found around the vessels in the orbital region; also excess of lymphocytes and endothelial cell proliferation; there is proliferation of the glia cells, but not many spider cells are seen. Sections of the parietal lobule, ascending frontal, ascending parietal, pre-frontal, orbital and angular gyri were made, stained by Nissl's method and examined. In all these regions the cells of the molecular layer of Cajal, the small and medium sized pyramids were found diminished in numbers, distorted in shape, not arranged as a rule in columns, their processes are broken off, and the bodies of the cells present various atrophic and degenerative changes of varying degrees of intensity, although some of the cells exhibit a fairly normal appearance. The cellular changes were more marked in the prefrontal and frontal regions than elsewhere. These changes appear to be of the nature of a primary cell atrophy. The Betts' cells in the ascending frontal are in groups, and some cells of a group appear fairly normal, while others show chromolytic changes, eccentric nucleus, and breaking off of the processes, indicative of an acute change.

Examination of the same regions by the Weigert method showed corresponding atrophy and partial disappearance of the tangential, supraradial and interradial fibres most marked in the regions where the cell atrophy was most apparent.

Case 32.—Early ataxic general paralysis in a young married woman, the subject of syphilis (acquired before marriage, in all probability). Death in less than a month after admission from pneumonia. Left knee-jerk absent, right-sided fits, speech affection, right hemisphere weighed 20 grammes more than left.

H. W., aged 26 years, admitted to Claybury, June 21, 1901.

History (from husband).—No family history of insanity, patient's brothers and sisters all strong and healthy. Married seven years ago at the age of 19, and before marriage she was an upholsterer by trade. Husband states that occasionally she has been drunk, but he is sure that her illness was not due to drink. She was an attractive-looking, good, and affectionate wife, and came from a very steady, good-living family. The husband attributes her illness to an accident she met with while with child; this child was still-born with difficult labour. sequently she had five or six miscarriages, but no children. For six months, or possibly longer, as she hid it from her husband, she suffered with a bad leg. Patient was the second wife of Mr. W., and in about September last he lost his daughter, aged 10, a child of his first wife, and the combined worry, husband thinks, constituted the exciting cause of the patient's illness. He denies that he ever had venereal disease, and I judged after the interview with him that his wife had been infected before having relations with him. Patient never complained of pains in her legs, except from the ulcer. As her illness progressed she had visual hallucinations of policemen coming into the house; she also had delusions that each person she met was a policeman, and that he was coming to lock her husband up. For the last eight or nine weeks husband has noticed that her speech has been affected. She had two or three fits before admission, the mouth being drawn to the left side, following the fit, but afterwards it came to the normal position.

Condition on admission: Mental.—Rambling and incoherent in her speech, believes that she has not been out of her house for five to seven years. Physical.—The right pupil larger than the left, both fixed; the right knee-jerk present, the left absent. She was suffering with palmar psoriasis and a syphilitic ulcer of the right leg, with the usual characteristic brown pigmentation

around. The teeth were worn down, otherwise her conditon was good, yet she was unable to walk. Her speech and expression were characteristic of general paralysis. The memory was very much impaired, and she was dull and sluggish in answering questions, and she had no knowledge of time or place. When questioned she jumps up as if to attention, but cannot maintain herself in the standing position.

Died July 7, 1901.

Post mortem.—Body well nourished, physique good, muscular system developed, post-mortem rigidity just commencing. On the right leg there is an old ulcer 1 in. by 2 ins., with pigmentation all round, the extent being as great as could be covered by the hand, typically syphilitic. The pupils were irregular, but equal, both being 5 mm. in diameter. There was no obvious thickening of the pia-arachnoid, but sub-pial hæmorrhages over the frontal region; it was adherent along the mesial surface of the frontal lobes. Weight of encephalen 1,120 grammes, appearance normal, with the exception of the hæmorrhage referred to. Weight of right hemisphere 490 grammes, weight of left 470 grammes, weight of cerebellum and pons 160 grammes. There is some apparent wasting of gray matter n the pre-frontal regions of both hemispheres. The ventricles were not granular or dilated. The lateral sacs of the fourth ventricle were slightly granular.

Right lung, weight 450 grammes, lower lobe in a state of commencing red hepatisation, commencing pneumonia of upper. Left lung, weight 650, lower lobe semi-solid, sinks in water, in a state of red hepatisation, commencing pneumonia of upper lobe.

Heart and valves all healthy, no atheroma aorta. Liver rather pale and fatty, spleen softer than normal, kidneys pale, otherwise normal. Stomach, pancreas, &c., normal, intestines normal. Os uteri dilated, tough and fibrous, cyst in left ovary the size of a pigeon's egg.

Cause of death, immediate.—Double pneumonia.

Other pathological conditions.—Very early general paralysis.

General summary.—Had she not contracted pneumonia a week or two after admission, she might have lived several years, as her general condition was excellent.

Case 33.—Tabetic general paralysis in which the mental symptoms preceded the cord symptoms. Death within three months of admission. Characteristic brain and cord lesions.

E. A., aged 32, married, policeman; late Army Service Corps, admitted to Hanwell, October 26, 1899, suffering from symptoms of general paralysis (tabetic form).

Family history (obtained from wife).—He is one of a family of eight, all alive and healthy, father and mother both healthy, no history of insanity or other neurosis, no history of phthisis.

Personal history.—Informant has been married to him for ten years; as far as she knows he was always bright, happy, and healthy as a young man; was a good husband and father; was in the army for ten years before marriage; they have had four children, eldest 8, youngest 2, one child died, aged $2\frac{3}{4}$ of pneumonia. Wife has had no miscarriages, and no history of syphilis can be obtained from her. She has seen him occasionally the worse for drink, but denies that he was habitually a heavy drinker. After the death of his child eighteen months ago, she first noticed that he became absent-minded, forgetful and melancholy, and he was obliged to leave the police force. His speech was first affected about two months ago; he has had no fits as far as she knows; his gait has become affected since his admission to the Infirmary three weeks ago.

He has a scar on glans penis, and two large scars in right groin, shotty glands in both groins; in spite of the above evidence, he denied having had venereal disease.

Physical condition.—Body somewhat emaciated, heart and lungs free from any symptoms of disease, tongue clean, tremulous, protruded slightly to the right, gait staggering, marked incoordination of muscles of locomotion and inability to walk without support. The unsteadiness is increased with the eyes closed and there is some difficulty apparent in touching the tip of his nose. The knee-jerks are absent, and there is some hypotonus of the hamstring muscles. The pupils are small, the right a little larger than the left and give no response to light; accommodation active. Speech most inarticulate and slurred, making it difficult to understand what he says. There is marked tremor of the lips and tongue. Slight drooping of both eyelids. He complains of rheumatic pains in his legs. No loss of sensation was observed on testing him by pricking and touch.

Mental state.—Confusion of ideas, impairment of memory, and mild delusions that he has money in the bank. He is restless and sleepless.

November 30.—Paresis rapidly progressing, has lost control over his sphincters, but asks to be changed and cleaned; he is rapidly emaciating.

December 11.—Commenced having epileptiform seizures, and he died on December 13 from acute pneumonia.

The brain showed the macroscopic signs of early general

paralysis; the pia-arachnoid was slightly thickened and adherent over the fronto-central convolutions, erosions occurred on stripping, the gray matter was diminished, striæ indistinct. All the ventricles were somewhat dilated and granular. The spinal cord presented no naked eye change, but microscopical examination revealed early tabetic atrophy, as the subjoined microscopical examination shows:—

Fifth lumbar.—Slight diffuse sclerosis of posterior columns, except in the cornu commissural zone and the oval area. Slight diffuse sclerosis of crossed pyramidal tracts. Eighth dorsal.—Slight diffuse degeneration in posterior median column. Well-marked sclerosis of cornu radicular zone. Second dorsal.—Ditto Seventh cervical.—Slight degeneration of posterior median, better marked degeneration of band just outside this, coming, doubtless, from eighth cervical, first and second dorsal-fibres. At the base this spreads out to reach the posterior horn.

In no part of the cord were the endogenous fibres of the posterior columns obviously degenerated. The posterior roots show atrophy and denudation of fibres, especially in those regions where the posterior column degeneration is marked. The vessels and membranes show little or no change, and the cord presents little change in size or shape, for there is comparatively little wasting.

Case 34.—Ataxy and slight early seizures and symptoms of general paralysis, abeyance of ataxic symptoms, pronounced mental symptoms following seizures.

F. J., compositor, aged 49. Admitted to Colney Hatch. My attention was called to him by Dr. Seward on account of his ataxic walk. He gave a history of syphilis, scar on penis, and from his own account he had evidently lived a very rackety life. There was no history of insanity in the family. When I first saw him he was not much affected mentally, but he was ataxic; he had pains in the legs, unsteadiness in his gait, which was increased on closing his eyes. The pupils were equal, contracted to 3 mm. and did not respond to light, but sluggishly to accommodation. The knee-jerks were absent, and there was hypotonus in the limbs. The speech was hesitant and somewhat syllabic, and the tongue tremulous. Six months later when I saw him he was a most pronounced general paralytic; he had had seizures, and the speech was characteristic of advanced general paralysis. He had delusions of wealth, grandeur, and strength, and a markedly

exalted expression (vide photo). His walk was now a shuffle, but he could stand without any swaying with his eyes shut. The knee-jerks are still absent, but there is no hypotonus in the limbs. He subsequently died. The brain presented all the characteristic appearances of general paralysis. The spinal cord was forwarded to me for examination with the following results:—



Fig. 25.

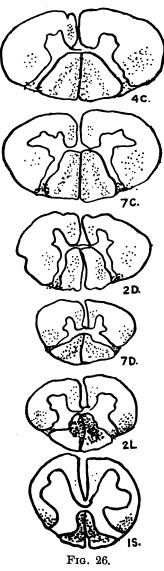
The photograph illustrates a condition of marked exaltation and grandiose delirium; at the time this was taken the patient was telling me that his brain was geared up to 990,000.

Microscopical examination.—The sclerosis, although most obvious in the exogenous systems of the posterior columns, is not limited thereto, as there is a very definite sclerosis in the comma tract, but the cornu commisural zone of Westphal in the lower dorsal and lumbo-sacral regions is intact. There is diffuse sclerosis of Goll's column in the cervical region and a well-marked

band of sclerosis corresponding to roots supplying the upper limb. There is well-marked atrophy and denudation of fibres in the middle third of the postero-external column corresponding to Charcot's root zone in the dorsal and lumbo-sacral regions, with atrophy and disappearance of many of the fibres of the plexus around the cells of Clarke's column. This atrophy is most apparent where Clarke's column is most developed—viz., in the lower dorsal and the upper lumbar regions.

The median oval area of Flechsig, and Gombault and Phillipe's posterior triangle appear to be only slightly denuded of fibres. There is some acute degeneration of the crossed pyramidal tracts on both sides throughout the cord, and a little degeneration in the direct tracts (vide chart).

Case 35.—Tabes of two or three years' duration, very advanced in legs and arms. Gastric crises. Bladder and bowel troubles. Admitted to asylum suffering with mania, exalted notions, and intellectual confusion.



N. A., admitted to Colney Hatch May, 1901, Russian Jew, aged 33, a tailor by occupation, has to do a great deal of walking, and always stands at his work as a cutter. He has been fifteen years in England, married nine years. After marriage, wife had four miscarriages, then three children died in early infancy, finally two living. At 15 years of age the patient contracted a chance, which was treated for two years, suffered with sore throat, rash, and falling out of hair. There is no scar visible; glands in the groin are enlarged. He is a temperate man, smokes; there is no history of insanity in the family.

Physical condition.—He has a difficulty in standing and walking, which he says commenced two years ago. He was treated at St. Mary's Hospital twelve months ago for shooting pains in the legs, cord-like feeling round the waist, and loss of memory. He now walks with a jerky wide base, heels down first. complains that occasionally his legs have given way under him. Romberg symptom marked, knee-jerks absent, sense of position of joints lost, especially in legs, very marked hypotonus of hamstring muscles. Superficial reflexes exaggerated, pupils unequal, right 2½mm., left 1½mm., inactive to light, active to accommodation, says that he does not see well with the left eye. Complains of a frequent desire to micturate, and difficulty in passing water. He has trouble with his bowels and bad attacks of vomiting. His speech is syllabic and tremulous. Being asked to write his name and address, he held the pencil between the side of the middle finger and tip of index, and the writing, like the speech, was very ataxic, syllabic and tremulous. There was slight tremor of the lips and tongue noticed.

Mental condition.—There is some mental confusion and incoherence, and a moderate amount of exaltation. He thinks that he has £250 a year from the War Office, that he is a General in the 17th Lancers, but on questioning him, he knows nothing about the regiment. He is the owner of a diamond factory in Birmingham. There is a sub-stratum of truth in these delusions. With regard to the former statement, he probably makes uniforms for officers in the Army, and a good cutter, such as he may have been, would easily make £250 per annum. With regard to the second statement, like many other of these aliens, he has been in South Africa, and possibly in the illicit diamond trade.

No doubt there is considerable disturbance in the sensibility of the skin, but the facts elicited on this occasion were not considered sufficiently reliable to be included in the notes.

Case 36.—Tabo-paralysis, commencing with a fit, followed by transitory aphasia. Later typical signs and symptoms of ataxy, melancholia, attempted suicide, progressive degeneration of brain and cord, with delusions and illusions, death, with typical naked eye signs in the brain of general paralysis.

A. H., aged 38, admitted to Hanwell, July 31, 1896, for melancholia and attempted suicide, which he nearly succeeded in accomplishing by cutting his throat, the scar of which is evident. Occupation, fireman on an engine, standing all the time, exposed

to weather and the heat of the furnace. He attributes his ataxy to his occupation, and he is very depressed in consequence of his being unable to continue his work.

Family history.—Maternal uncle died in an asylum.

Personal history (from the wife).—She has known the patient for eleven years. During this time he has always been ailing. For the past five years he has been much worse. Five years ago he had a seizure of some kind, and lost power of speech for two days. Since that time his speech has become much worse. In 1892 he found a difficulty in walking in the dark, and he had a velvet-like feeling on the soles of the feet. Twelve months ago he complained of a girdle sensation, followed by what were evidently rectal crises. Later on he suffered with loss of sexual power. His mind became affected after a severe fit which he had fourteen months ago. On the 1st of June last he had another fit. remaining unconscious for one hour. The medical certificate states that he is simple and childish, laughing insanely when spoken to. He had collected a lot of useless buttons, pebbles, bits of clay pipe, and attempted to explain the uses to which he would put them. His statements are rambling and contradictory. Twelve months ago he attempted suicide.

Present state (August, 1896).—He has an expression of depression, but I could discover no delusions or mental affection beyond this extreme depression, due to his being in an asylum, and unable to maintain his wife and children. His knowledge of time and place are good, likewise his memory for recent and past events. There is no tremor in the tongue, or face muscles, nor is the speech obviously affected. There is no ocular paralysis, no signs of syphilis on the body, and no history of the disease, but the possibility cannot be absolutely excluded. He is temperate in habits. He has a marked ataxic gait, Argyll-Robertson pupils, absence of knee-jerks, loss of sense of position in lower limbs, not in upper; complete loss of power over rectum, partial over bladder, cutaneous anæsthesia could not be determined in a reliable manner, owing to his refusal to answer.

November, 1897.—Patient suffered with severe epileptiform attacks, followed by delusions of persecution. People are putting dung in his food, and are playing upon him with electricity; his gait is not so ataxic.

August, 1898.—He is still suffering with delusions of poisoning, accompanied by great mental depression. He had been suffering with dysenteric diarrhea, and he considers it was due to the medicines and food.

April 27, 1899.—The notes state that he has become paralysed on the left side of the body; he is still suffering with delusions of poisoning, and people playing upon him with electricity, and he is more demented.

July 31, 1899.—Patient is certified as dying from dementia and paralysis. The *post-mortem* notes state that the brain weighed 46 ozs.; the convolutions on the right side were the seat of extensive atrophy and white softening in the ascending frontal, first temporal and angular gyri; wasting of the left leg is also noted.

Case 37.—Tabo-paralysis. Grandiose delusions, acute mania, macropsy, slight ataxy, pains attributed to electricity, auditory and visual hallucinations. Death eight months after onset of mental symptoms.

N. E. E., aged 46, admitted to Hanwell, June 28, 1901; occupation woodcarver and turner. His work necessitated standing all day.

Personal history (from wife).—He has been worried lately a good deal by the foreman on account of his inability to perform the work satisfactorily. He has been married twice, but has no children. His first wife had one miscarriage. He has been married to his second wife sixteen years. Patient's father died raving mad, was very intemperate, probably mania à potu, as the delirium was only a few days before death. An aunt was very eccentric, no history of phthisis. Patient when very young had fits between the ages of 4 and 6, but none since. He has been a steady, temperate man, thoroughly moral and very clever and industrious. The wife says that two doctors pronounced the opinion that the patient had syphilis when he was a young man, for which he was treated for some time. The patient himself, when questioned about this, said it was what is called a soft sore; it was only treated locally.

History of present illness (from wife).—Eight or nine years ago he suffered with dyspepsia and dilatation of the stomach. He has always been an excitable man, and his health has broken down latterly. He has complained of his eyesight, and he has had sharp shooting pains in the legs. The mental symptoms started about six months ago with extravagant ideas.

Physical condition.—Gait not ataxic, but walks with a slightly wider base than usual, Romberg symptom is absent, muscles well developed and strong, knee-jerks absent, superficial reflexes exaggerated, some hypotonus of hamstrings, legs can be raised

nearly to right angles with the body, no loss of joint sensation, no loss of sense of position. Pupils 2 mm., equal, irregular outline, inactive to light and pain, active to accommodation. When looking straight forward, the pupils dilate upon his entering into conversation. He tells me he has the sensation of everything appearing very large. This statement he volunteered. Colour vision is good, he can read small print, and the fields are not limited.

Expression anxious and depressed, but when conversing, his face becomes very animated and emotional, and there is tremor in the lips. The tongue also is tremulous, the speech, however, is but very slightly affected. There is no history of fits before admission or since. He has had no feeling of constriction round the waist, and there is no difficulty with the water or the bowels. No scar or enlarged glands can be detected, but there are numerous small-pock-like scars on the forehead and a few on the legs. I could detect no cutaneous anæsthesia. His handwriting is good, and like his speech flowing and not tremulous, but it does show slight cutting up of syllables, (?) pathological.

Mental condition.—When brought to the asylum he was singing the Marseillaise with patriotic fervour. He is now full of grandiose delusions, some of which have a basis of truth, e.g., he says that he is a great singer. He illustrated this by singing several songs in French with considerable expression, excellent articulation, and with a fine resonant voice. He then burst forth into the Marseillaise, singing it with extraordinary stirring patriotic fervour, suiting the action to the words. He was very pleased with his own performance, and spoke of kings, diamonds, and wealth. During his conversation, the muscles of expression associated with hilarity were especially brought into play, and the pupils dilated, but on ceasing, the same wearied lack of expression occurred.

August 20.—Patient in a side room, pale and emaciated, continually talking to imaginary persons, making lunges at the wall, or jerking his hands in the air as if throwing off some imaginary objects on his body. For the last few days he has employed himself rubbing his skin, especially of the knees and feet, with his shirt or bedclothes, muttering "electricity." He has thus caused several sores on his body. These symptoms indicate auditory and visual hallucinations and lightning pains in the legs.

The patient became very emaciated and died September, 1902. The brain showed characteristic signs of general paralysis, and the spinal cord exhibited early tabic degeneration of the posterior columns in the lumbo-sacral region, and slight sclerosis of Goll's column in the dorsal and cervical regions, after hardening in Muller's fluid.

Case 38.—Tabetic general paralysis, onset of tabetic and mental symptoms apparently simultaneously, arrest of tabetic condition, but slowly progressive dementia, symmetrical perforating ulcers of feet, knee-jerk absent on right side, present on left, speech for a long time only slightly affected, moderate exaltation and incoherence, knowledge of time and place not markedly affected.

W. D., aged 38, butler, married, with six children, admitted to Colney Hatch, November, 1897; history of six months illness, and certified as suffering from early tabetic general paralysis, history of syphilis at the age of 16, pigmented scar of old gumma on leg.

Physical condition.—Tall powerful man, walks with rather a wide base, heels down first, but no incoordination or jerkiness in his movements, can stand with his eyes shut, knee-jerk absent on the right side, present on the left. He can touch the tip of his nose with the forefinger of the left hand, but not accurately with the forefinger of the right.

Speech, no slurring of syllables, but slight hesitancy, can utter test words and sentences fairly well, without elision or slurring of syllables. There is no tremor of lips, and very slight of tongue.

Mental condition.—Mild dementia and confusion, but no marked loss of knowledge of time or place. He has delusions, but there is a substratum of truth, e.g., he says he knows all languages. Having been in the service of the French Ambassador as butler, he has probably heard many languages spoken, and doubtless, occasionally picked up a few words; certainly he knows a few sentences of French, German, and Italian, but he fails to understand simple questions put in French or German, although he will make an attempt to reply in the language by which he has been addressed. A few months after he had been in the asylum he developed two symmetrical perforating ulcers of the feet. The ataxy did not increase, but the dementia slowly progressed. He had no fits.

In October, 1899, he told me his age was 27, that he had a daughter who was married. There is a little more speech

affection, and the attendant says he is very restless at night, getting up continually to make his bed and brush out the flies which he imagines are walking over him (?) formication. He appears to feel pricking and touch in all parts of his body, but it is difficult to be certain on account of his mental condition.

November 14, 1900.—The left foot and leg are much swollen owing to an infective cellulitis, the knee-jerk on this side is still obtainable, but is absent on the right. The speech is more hesitant and slurred, knowledge of time and place more defective, and he now has grandiose delusions of wealth. He states that he has lots of money in the bank, and he will present each of us with a gold watch.

June 1, 1901.—Dementia more marked, has a delusion that he is the Prince of Wales, expression exalted. Nutrition fairly good, appetite ravenous, knee-jerk cannot now be obtained on either side. Pupils each measure 3½mm., irregular in outline, inactive to light, but react to accommodation. For a long time past he has persisted in getting up in the night to make his bed, he continually brushes the sheets. When the attendant asked why he did this, he said there were flies in his bed walking over him; very possibly this is a delusion based upon formication, owing to the cord affection.

Case 39.—Advanced tabes of at least four years' standing. Delusions of persecution and auditory hallucinations then developed with mental excitement. Slight organic changes in the brain, especially of the frontal lobe, most advanced spinal sclerosis in posterior column.

L. W. K. Admitted February 1, 1900. Stockbroker's accountant, aged 50. Single.

Previous history (from brother on July 13, 1900).—Maternal grandfather drank heavily, and a distant relative has been in Earlswood for more than thirty years. He had syphilis between twenty-five and thirty years ago. Abstemious for many years, but previously drank. He has had a considerable amount of mental worry. During the past two years at least, and probably for three or even four, he had walked very badly, raising his feet high from the ground; the pupils of his eyes were like pinpoints. His present mental condition began quite suddenly just after Christmas, 1899. Shortly before Christmas he seemed very jovial and behaved in an artificial manner, and a week after Christmas he began to ramble in his conversation. He said that people

were posting notices on walls about him. He told his brother not to go to his office, as there was a conspiracy against him. He wandered from home for the whole of one day, but returned of his own accord. He slept badly during the week referred to, he was then admitted into Hammersmith Infirmary, and a week later was transferred to Claybury.

Facts stated in certificates.—Patient is excited, hears voices, says there is a conspiracy against him, that his brother has stolen his money, and that he knows himself that he is suffering from hallucinations. He jumps up in bed at night and calls out. Brought to the asylum in a straight jacket.

Present state—Physical.—Height 5 feet 7 inches, weight 9 stone 4 lbs. Two broken ribs on left side. Tongue coated, appetite good. Bowels irregular, urine and viscera normal, pupils irregular, contracted, and do not react. Unable to stand with eyes closed, gait tabetic, knee-jerks absent. Mental.—Dazed, lost, confused, and depressed, very restless, and constantly wandering about, short-tempered, impulsive, violent, and given to striking out at the attendant. He hears imaginary voices accusing him "of stealing and owing money," heard "his brother groaning in the next room," sleeps badly, but takes his food well, and is clean in his habits.

Is suffering with mania and from tabes, is emotional, and his statements are contradictory and incoherent. He believes there has been, and there is a conspiracy against him for stealing a young lady's jewels, and assures me that it is false. His memory is impaired. He believes that some one is pointed out to him as his brother who is not, and he has aural hallucinations. He is full of nonsense about a certain young lady, and the wrong he has done his brother. He feels that his food has been tampered with for years, because he has seduced his mother's servant and given her syphilis, and says that her husband has been following him to take his life. He is in poor health and fair nutrition. He cannot stand with his feet together blindfolded. His gait is tabetic, his pupils are contracted, pinpoint, and inactive. He admits syphilis twenty-five years ago, he complains of shooting, neuralgic pains in his legs for some years, although nothing, he states, is to be seen.

February 21, 1900.—Impulsive, quarrelsome, and violent, but does not now appear to be troubled with auditory hallucinations.

April 30, 1900.—He is considered to be a general paralytic. Signs of progressive dementia.

August 1, 1900.—He is now constantly wet, and very ataxic.

October 23, 1900.—Stamps with his heels in walking, and throws his legs about somewhat, tongue very tremulous, speech rapid and slurred and without "r's." He is failing very rapidly, and is very wet and dirty in his habits. The knee-jerks are absent, there is hypotonus to the extent of 20° beyond the vertical. When relaxed, the right pupil is $1\frac{2}{3}$ mm., and the left is $1\frac{2}{3}$ mm., the pupils rapidly accommodate, the right to 1 mm., and the left to 1 mm. Both pupils are irregular and inactive to light.

October 30, 1900.—Rapidly became feebler, and died this morning at 9.50 a.m.

Abstract of notes of post mortem.—Poorly nourished, bedsores on both buttocks and over sacrum, doubtful scar on glans penis. Head.—Skull cap dense, dura mater natural at the vertex, thin brown film above the tentorium and in the anterior and middle fossæ, and most marked on the left side. Slight excess of subdural fluid, pia-arachnoid somewhat thickened, and strips rather more readily than natural. No adhesions in the mid line of the pre-frontal region, but there is considerable granularity of the pia in this situation. The pia here is also adherent to the subjacent cortex, which is congested. The basal vessels are natural. There is no definite change in the optic nerves; the left olfactory tract appears to be smaller than the right, and both seem to be smaller than natural. Brain weighs 1,395 grams, natural, except for some fronto-parietal wasting. Each hemisphere weighs 600 grams, cerebellum and pons weigh 175 grams; the brain having been weighed without draining, this only leaves 20 grams of fluid. The hemispheres are normally convoluted. The cortex is dark and congested; the rest of the brain is not congested, but the whole is somewhat wet, without the condition being that of definite cedema. The lateral ventricles are slightly dilated, and contain a few doubtful granules. The fourth ventricle throughout its extent appears to be covered with small granulations. After the hemispheres had been in formol for two days, and the ependyma had become hardened, all the ventricles were obviously granular. Cartilages natural, ribs brittle. On each side of the thorax there was evidence of old-standing fracture of five or six of the lower ribs in front of the mid axillary line. Both lungs broncho-pneumonic and edematous. adhesions. Throughout the aorta was a large amount of atheroma (first and second stages); there were no calcareous plates, but numerous pearly-white patches of fibrosis. Ureters inflamed throughout their course, acute cystitis, testicles natural. The brain, after having been hardened in Muller's fluid, showed some thickening of the pia arachnoid over the motor area, particularly the upper part, and Broca. The above-named convolutions were shrunken.

Microscopical examination of the brain.—Sections stained by Nissl method showed acute changes in the small, medium, and large pyramids, and overgrowth of glia cells. There was some cell proliferation of the perivascular lymphatics in Broca's convolution. The left ascending frontal and parietal showed glia cell proliferation, especially in the deeper layers of the cortex, acute degenerative changes in the nerve-cells, and displacement of Meynert's columns. In the posterior part of the first left temporal there was very little change observed; the same applies to the calcarine. Orbital mesial surface.—The vessels showed abundance of plasma cells in the lymphatic sheaths. The pyramidal cells had lost their normal shape, and many of them were atrophied, but there was no marked glia cell proliferation in this region.

Marchi method.—A slight amount of recent degeneration was observed in the white matter. In the ascending frontal and parietal there was considerable recent degeneration of radiating fibres, more obvious than usually met with in general paralysis cases; fine black dots could be traced into the second layer, but, probably, these fibres do not come from the pyramids of the third layer. Nothing noteworthy is to be seen in the first temporal or calcarine; only a few degenerated fibres can be seen, but they are practically inconsiderable in number, compared with those of the fronto-parietal region.

Marchi-Pal.—Broca's convolution.—The tangential and superradial fibres are absent, and the interradial diminished in number. Base of first frontal, ascending frontal, ascending parietal.—In the first-named convolution the tangential fibres are absent, in the other two they are greatly diminished, and in places absent altogether. The super and interradial fibres are less affected than the tangential, but they are diminished in number; there is no thickening of membranes and but little congestion of vessels. First temporal convolution—there is a marked diminution of tangential fibres, less of superradial and interradial. There is no apparent thickening of membranes or vascular change noticeable. The same remarks apply to the occipital lobe in the region of the calcarine fissure, except that the vessels are passively congested (due to position). In the orbital lobe the tangential and superradial fibres are entirely gone, and the interradial greatly diminished in number, the cells stained with osmic acid as if they

were undergoing fatty and pigmentary degeneration. The spinal lesions are shown in the accompanying diagram which explains itself. It may, however, be remarked that each segment of the cord was examined and drawn by means of an Edinger projection apparatus, and it will be observed that there is no appreciable flattening of the posterior surface of the cord, although there is very obvious shrinkage in the transverse diameter of the posterior column. This also is shown strikingly in the photomicrograph. From the second to the eighth dorsal there is almost complete absence of fibres in the posterior roots at their attachment to the

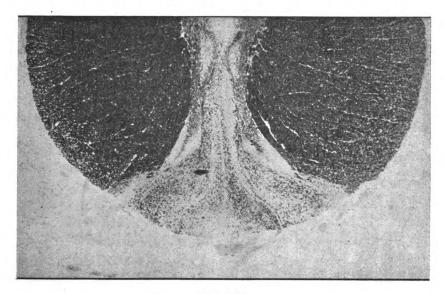


Fig. 27.

Section of spinal cord at level of eighth dorsal segment. There is no flattening of the posterior column; it is even more convex than normal. There is, however, very marked shrinking and distortion of the gray matter and of the posterior column, so that the columns of Clarke are almost in apposition. The fibre plexus around the cells is completely atrophied, but encircling the columns are two sets of fibres, one external, proceeding from the gray matter of the posterior horn, the other internal, continuous with the fibres of the postero external zone.

Magnification 16.

cord, and in the same region a very complete degenerative atrophy of the exogenous fibres in the same regions of the cord. The degeneration below this eighth segment is not so marked but still very extensive. The endogenous tracts are atrophied but to a much less degree. Black indicates complete absence of fibres, dots partial absence. It will be observed that there is scattered crossed pyramidal degeneration which, however, cannot be traced above

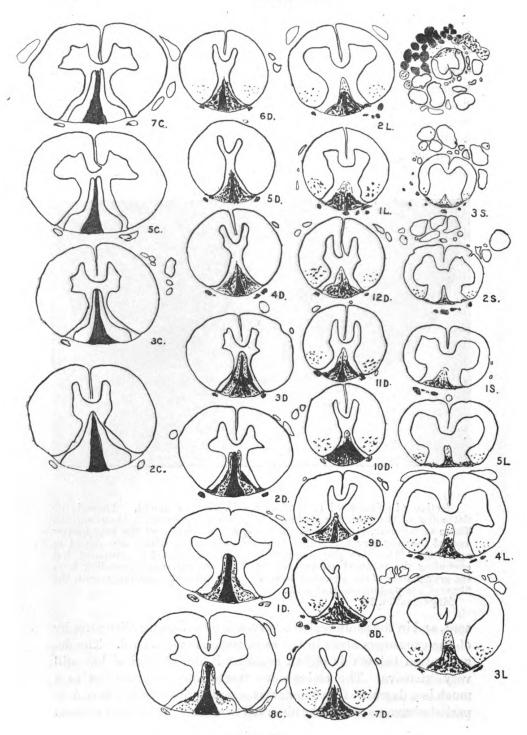


Fig. 28.

Note degeneration in crossed pyramidal tracts, which ceases in mid-dorsal region.

the mid-dorsal region. The posterior spinal ganglia showed only some pigmentary atrophy of the cells. The fibres distal to the ganglia were normal, whereas the central proximal fibres were completely or nearly completely devoid of myelin or had entirely disappeared. It was noticed that, whereas the myelin could be seen on some of the attenuated fibres, as they proceed centrally from the ganglion, after a short distance it The atrophy of the fine plexus about seemed to disappear. the cells of Clarke's column was very extensive, indicating marked affection of the cerebellar path. Lissauer's zone was also pretty extensively atrophied in the lumbo-sacral region: it was, however, variable on the two sides and at different levels, corresponding pretty closely with the degree of atrophy of fibres in attached roots.

Nerves.—Right posterior tibial. Longitudinal and transverse sections show some degenerated fibres, but the degeneration appears to be not the Wallerian degeneration, but a swelling and opacity of the myelin in many of the fibres by which it stains imperfectly. Some of the fibres show merely empty primitive sheaths, and in longitudinal section these fibres are seen at intervals to exhibit coagulated balls of myelin or smaller myelin droplets. The anterior tibial nerve shows this change even more distinctly.

Transverse sections of the sciatic nerve show paucity of fibres in many of the bundles, but whether there is a real atrophy or not it is difficult to decide.

Skin of great toe—very few small bundles of nerve-fibres are seen, certainly less than normal. Examined with a high power one sees not more than one-third of the fibres are stained blue.

Degeneration of the peripheral nerves, especially of the remote parts does exist, but it is inconsiderable as compared with the posterior roots.

Optic nerves—transverse and longitudinal sections show by Marchi method many recent degenerated fibres scattered over the whole field, but more marked at the periphery, where also could be seen many bundles showing advanced atrophic degeneration.

- Case 40.—Ataxy with slight mental symptoms, altered respiration from failure of synergic action of muscles of abdomen, complete destruction of all the fibres of the posterior roots in the lower dorsal region of the cord.
- F. S., aged 61, married, chairmaker; has had seventeen children, fourteen living. He had syphilis at the age of 25. He

was treated for it medicinally for a long time. His symptoms began with lightning pains, some years ago, exact time not known. He had been a considerable time in the infirmary, and was admitted to Colney Hatch, May 28, 1896, for mania.

Present condition.—No discoverable mental symptoms, except feeble-mindedness, he is markedly ataxic, muscles greatly wasted, has girdle sensation, lightning pains, knee-jerks absent, plantar reflexes absent, abdominal reflexes greatly diminished on left, absent on right side. Argyll-Robertson pupils. There is loss of muscular power in the legs, and marked hypotonus, but his arms still possess considerable strength. There

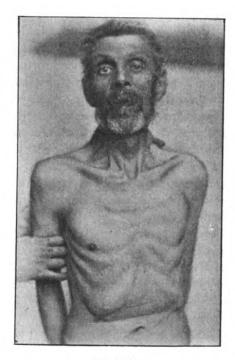


Fig. 29.

is marked incoordination of the lower limbs. With his fingers he can readily touch the tip of his nose, when his eyes are shut. The belly is retracted, and there is complete atrophy of the left, and partial atrophy of the right quadratus lumborum and oblique muscles. Upon taking a deep respiration the lower ribs are drawn inwards, and a groove is formed (vide photo.). There

is also great atrophy and weakness of the muscles of the lower extremities, they react to faradism, but require a stronger current than usual. There is no absolute loss of sensation anywhere in the legs, but it is much delayed and blunted, and there is numbness of the soles of the feet. The trunk was not tested; there is also complete absence of sexual power, and loss of control of bladder and rectum. There are symptoms pointing to rectal crises, but no gastric, larnygeal or other crises.

July 1, 1896.—Condition of patient much the same, but there has been gradual loss of muscular power, and he is now bedridden. Left abdominal reflex is now quite absent. (F. W. M.)

October 14, 1896.—Patient died to-day of exhaustion.

Autopsy.—Fifteen hours after death. Body extremely wasted, and there is a large bed sore over the sacrum. The viscera presented no signs of disease except the bladder, the mucous membrane of which was thickened and inflamed. Naked eye sclerosis was visible in the posterior columns of the spinal cord.

Microscopical examination (by Dr. Hamilton Wright) -Brain.—Some pia-arachnoid thickening in frontal and central regions, with chronic atrophy of superficial fibres belonging to tangential and supraradial systems. Spinal cord.—Cervical enlargement.—The postero-median columns are denuded of fibres, and markedly sclerosed, except at their extreme apices, in the position of the endogenous cornu commisural zone. The inner halves and almost the whole of the median parts of the postero-external columns, show marked sclerosis, with a very few fibres only left. A few fibres have disappeared from the root zones, and they are slightly sclerosed. Lissauer's tract on both sides is partially atrophied. There is a partial atrophy of the roots of this region, external to the cord. Many of the fibres still in situ are undergoing degeneration, and there is some fibrous tissue substitution. The right lateral column presents a marked degeneration, confined in the main to the anterior extremity of the direct cerebellar tract. The whole of this tract, however, is the seat of a diffuse fibre atrophy and sclerosis. On both sides there is a slight degeneration of fibres and sclerosis of the crossed pyramidal tracts. The Weigert-Pal method, which was employed for this investigation, revealed no degeneration in any part of the gray matter. Many anterior cornual cells are shrunken and much pigmented. There is a slight rarefaction in the posterior horns, probably the result of the few posterior root-fibres which course through them.

Thoracic region.—At this level there is a marked atrophy of fibres in the postero-median columns. A few only are left, and these are in a state of chronic atrophy. The postero-external columns, except in the most anterior parts, and along the median margin of gray matter, exhibit marked sclerosis. The fibres of Lissauer's tract have wholly disappeared; all these parts are the seat of a marked sclerosis. A few fibres are left in the position of the cornu-commissural zone. The comma tracts are almost totally atrophied. The extra-cordal portion of the posterior roots contain no sign of nerve-fibres, but only a scattered débris. On the right side of the cord the crossed pyramidal tracts



Fig. 30.

Section of spinal cord at level of lowest dorsal region. There is complete atrophy of Lissauer's tract extending into the region of the direct cerebellar tract, each side of which is also atrophied. The entering root-fibres have completely disappeared. The fibres in the posterior column are mainly continuous with the two bands of fibre which encircle Clarke's column, and are in all probability endogenous. The fibre plexus around the cells of Clarke's column is completely atrophied. The central canal is dilated.

show an atrophy of quite one-third of their fibres, and are deeply sclerosed. There is only a slight atrophy and sclerosis in this tract on the opposite side. Both posterior horns are greatly wasted. In the right horn no proper tissue is to be observed dorsal to its neck. The opposite horn contains here and there a sign of proper tissue posterior to Clarke's column. Clarke's columns are denuded of fibres of all kinds. The right column of Clarke contains no evidence of nerve-cells, except in the lower segments, and even here they are greatly shrunken and deeply pigmented. A few only are to be observed in the opposite

column, all greatly shrunken and pigmented. The posterior gray commissure contains only a few vestiges of fibres. The gray matter of the anterior horns is shrunken and rarefied, its cells are deeply pigmented and exceedingly few in number. The anterior roots on the left side are almost totally atrophied. On the opposite side a few fibres are still to be observed. Lumbo-sacral region.—The only fibres left in the posterior columns of this division of the cord are in the position of the cornu-commissural zone, along the median margin of the left posterior horn and in the left root zone. Even here they are few, greatly attenuated, or irregularly swollen. All other parts are intensely sclerosed. There is no sign of the median triangle of Flechsig, or the sacral fibres of Gombault and Phillippe. This is an important point in view of the sphincter paralysis. The posterior roots on the right side are totally atrophied. A few extremely wasted are still present on the left side. In the lateral columns of this level the atrophy of fibres, and the consequent sclerosis is apparently not so great as in the thoracic region. It appears to be equal on the two sides. The posterior horns contain only a few fragments of fibres in the substantia gelatinosa. The cells appear to have totally atrophied. The necks of the posterior horns are greatly rarefied and sclerosed. Only a few remains of fibres are present in the posterior gray commissure, and none of these appear to bend backwards along the posterior median septum. The anterior cornual cells are shrunken and are deeply pigmented; it is difficult to decide whether any have totally wasted and disappeared, but it is not unlikely in view of the state of the anterior roots. On both sides the root-fibres have in great part disappeared, and the majority of fibres that remain are attenuated. The piamater is thickened, and the superficial layer of neuroglia beneath it appears to be augmented throughout the cord, especially where the sclerosis is marked. There is a great congestion of the pial, and deeper vessels; thickening of their coats has occurred in the pia, and in those parts of the cord where atrophy of fibres has been followed by sclerosis. Posterior spinal ganglia in the cervical region were not examined. In the thoracic and lumbo-sacral levels there is considerable degeneration of the cells. The most noticeable feature is a general pigmentation; in many instances no vestige of the cell is to be seen, and the capsule is full of dark brown pigment. Many cells have stained purplish blue by the Weigert-Pal method, indicating fatty degeneration. A few cells are reduced to a granular debris, in the centre of which is a turgid granular nucleolus, the nucleus having entirely disappeared. The capsules are thickened, and the general interstitial overgrowth is marked. The vessels are congested, and their walls slightly thickened.

Case 41.—Tabes, probably of some standing, homicidal and suicidal mania, grandiose delusions. Ataxia, mental and physical improvement, obvious ataxy disappears, attack of suicidal mania, left-sided convulsions, tremor of face muscles, but little speech affection. Death from intercurrent disease two years after admission. Naked eye and microscopical examination of brain and spinal cord exhibits first stage of ataxic lesion of cord and roots, heterotopia of central canal in lumbo-sacral region. Changes in cortex cerebri of general paralysis.

H. J. B., telegraphist, aged 41, admitted to asylum, Cane Hill, December 28, 1897. Died December 14, 1899. Medical certificate states that he had threatened to shoot his wife and then himself. Before admission to the Infirmary he had been excited and emotional. He had suffered with unbearable pains, he had been the subject of grandiose delusions, pawned nearly everything for drink, stolen billiard balls, brushes and other articles.

History.—First attack. Duration of mental symptoms two months; first symptom noticed, sleeplessness and loss of flesh—has locomotor ataxy which began nine months ago; supposed cause, alcohol; married ten years, two children. No phthisis, insanity, or alcohol in family history. States himself that he had a soft sore for which he was treated with medicine for two months.

Physical condition.—Nutrition good. Tongue tremulous. Pupils unequal, Argyll-Robertson. Deep reflexes absent. Plantar present, marked. Gait, walks with a wide base. Romberg sign. Complains of pains, no visceral disturbances. No evidence of organic disease of abdominal or thoracic organs.

Mental condition.—Talkative, rambling, irrational. He has exalted notions of his powers as an athlete, musican, and elocutionist, but I found that these are not strictly delusions, but exaggerations of undoubted faculties possessed by him. He has, however, true grandiose delusions, for "he possesses a gold mine." Speech somewhat hesitant and tremulous, especially of lip explosives.

After some weeks he improved mentally and physically and nine months after admission he was able to work in the fields five hours a day.

June 19, 1899.—The notes state that he has been having

convulsive seizures, and six weeks ago he had an attack of suicidal mania, attempting to mutilate himself and gouge out his eyes. There is now more dementia indicated by the blank facial expression and his conversation. He does not respond regularly to the calls of nature. Tremor of facial muscles more marked. Beyond walking with a wide base no sign of ataxy. He is dangerous to himself and others.

December 5, 1899.—Patient helpless, bedridden, and demented; death occurred a week later from broncho-pneumonia and cystitis.

Autopsy (summary of notes).—Old scar on glans penis, no bed sores. Skull cap thick and dense. Dura mater adherent to pia-arachnoid over central convolution of left side. Pia-arachnoid of pre-frontal and central convolutions, thickened, opaque and milky. Some wasting of convolutions and cortex somewhat diminished. Fourth ventricle dilated, granular ependyma. Brain—right hemisphere 17½ ozs., left 17½ ozs. Cerebellum and pons—5 ozs.

Cause of death.—Broncho-pneumonia, cystitis and pyonephrosis.

Microscopical examination (summary).—Atrophy or absence of tangential and superradial fibres in various situations of atrophied convolutions, marked vascular congestion, with numbers of plasma cells in perivascular lymphatics. Atrophy and degeneration of small and medium sized pyramids. Glia cell Spinal cord.—Some leptomeningitis not more proliferation. marked posteriorly than anteriorly, the same applies to vessels which are congested and their walls thickened. region the degeneration is limited to Goll's column. By Marchi method there are scattered fibres degenerated in all the white matter. In upper dorsal and mid dorsal regions there is extensive atrophy of root-fibres and their intraspinal projections. In lower dorsal region there is also some diminution of fibres in the comma tract. Lissauer's zone is most affected about the fourth and fifth dorsal, where the roots are most denuded of fibres. About the eighth dorsal, but not above this, there is obvious sclerosis of the crossed pyramidal tracts, which becomes more obvious as we proceed downwards. In the lowest dorsal and lumbo-sacral regions the roots are not so markedly affected and the degeneration in the posterior column takes the characteristic winged appearance, the apex of the wing on either side corresponding to the root zone. There is not a marked atrophy of the fine plexus around the cells of Clarke's column.

A more than usual number of coarse fibres persist in the sclerosed posterior roots. The endogenous fibres in this region are but little affected. At the level of the fifth lumbar segment and extending into the sacral segments is a dilation of the central canal which extends back as far as the posterior surface. not an artefact for it is lined with the characteristic epithelium, and represents a congenital failure to close up the canal in this region by the ingrowth of fibres. At the posterior surface and corresponding to the mesial line is an agglomeration of vessels, dense fibrous tissue and a few bundles of embryonic muscle fibres. In the fibrous tissue also there are scattered groups of ganglion cells, and small nerve-fibres. The cord in this region, and, indeed, throughout the lower dorsal and lumbar region is very small. One structure, however, is not diminished more than another. It appears to be a failure in development. In a section of the last lumbar spinal ganglion, in what corresponds to the white ramus are a group of cells which stain slate blue with the Weigert method, and from these issue a number of coarse medullated Whether this is an abnormal condition I am unable to fibres. say.

Conclusions are (1) that this patient had thoracic cutaneous anæsthesia, had it been looked for; (2) That the ataxy was not a permanent feature of the clinical symptoms, because there was neither marked atrophy of the fine plexus around Clarke's column, nor was there much atrophy of the lumbo-sacral region, except of the fibres concerned with reflex spinal tonus; moreover the endogenous fibres were not affected in the lumbo-sacral region. Therefore, the ataxy that existed was due more especially to a condition which might under circumstances vary, viz., the reflex spinal tonus and its inhibition by cerebral influence.

The general atrophy of the cord indicates a general nutritional defect; this is frequently met with in these cases of tabo-paralysis, but in this case it might have been congenital.

Case 42.—Tabetic general paralysis, with characteristic pathological changes affecting the brain, spinal cord, posterior roots, and optic nerves. Marked degeneration of fronto-occipital and fronto-temporal association tracts, causing dilatation of lateral ventricles.

J. H., aged 37, occupation a tailor, admitted to Claybury, June, 1899.

Abstract of notes.—Married eleven years, three children, two alive, one dead. Wife states that he had fits, and had complained of pains in his legs for two months prior to admission. There was a history of insanity on the father's side.

Mental state on admission.—He is noted as being strange in his manner, wandering constantly from one subject to another, so that it was difficult to obtain from him a coherent account. He states that he hears voices talking to him at night. He has no idea of time or place, and he believes that his wife and family live here. He is under the delusion that he has murdered some of his children by strangulation, and he wants an operation performed on his legs, presumably on account of the pains.

Physical state.—There is marked shortening of the right leg, the muscles of which were very wasted, and there is evidence of old hip disease, (?) Charcot's joint. There are patches of alopecia on the head, and he states that he has had both gonorrhea and syphilis. The knee-jerks are absent, and the left leg is retroflexed, jerking and ataxic in movement. The pupils are unequal, the left being dilated and sluggish in reaction to light and accommodation; the right pupil reacts fairly readily. There is well-marked primary optic atrophy on both sides, more obvious in the left eye. Diagnosis at first was mania; towards the end of the year he commenced having seizures affecting especially the right side, the diagnosis of general paralysis was then made. At the end of January, 1901, he died of pneumonia and cardiac failure.

Post-mortem examination.—Body is well nourished, no external marks of syphilis, right leg 3 inches shorter than the left. Skull dense, excess of fluid in subdural and subarachnoid spaces. The pia-arachnoid was thickened and opaque in the frontal and fronto-parietal regions, convolutions were atrophied, though not markedly so; on stripping erosions were seen. The lateral ventricles were granular and dilated. The fourth ventricle was also granular. There was well-marked atrophy of both optic nerves.

Cause of death: (a) Primary.—Broncho-pneumonia and gangrene of lung. (b) Secondary.—Tabetic general paralysis.

Examination of spinal cord by Marchi and Marchi-Pal methods showed by the former a number of recent degenerated fibres in the crossed pyramidal and direct tracts, also scattered generally in the posterior columns. The degenerated fibres were seen at all levels of the cord, and were probably therefore mostly belonging to long systems. By the Marchi-Pal method denudation of fibres and subsequent sclerosis with a moderate proliferation of glia

tissue was found in the posterior columns of the spinal cord. In the cervical region this was almost exclusively limited to the leg fibres forming the column of Goll. In the lumbo-sacral region, where the denudation of fibres and subsequent neuroglia overgrowth was most marked, the atrophy of fibres was limited to exogenous systems. The only part of the posterior columns which did not show denudation of fibres was the cornu-commissural zone and the median oval area. The short length fibres of Lissauer's tract, the medium length cerebellar fibres, and the long fibres which together form Goll's column, are in great part destroyed or atrophied. The fibres of the posterior roots in many of the sections show considerable denudation of fibres. In the upper lumbar and lower dorsal region there is still a great diminution of exogenous fibres entering into the formation of the posterior columns, and there is a corresponding overgrowth of glia tissue. The atrophy of the fibre plexus around the cells of Clarke's column is only moderate. Cauda equina.—To the naked eye the sections show an obvious difference in the anterior and posterior parts. In the former the roots are of good size, and are stained blue, whereas in the latter the roots are atrophied and unstained. Examined microscopically, the posterior bundles are considerably shrunken, and exhibit very few fibres. Some are apparently almost destitute of fibres, consisting only, or for the most part, of connective tissue. The anterior bundles (motor) are normal in appearance. In both anterior normal and posterior sclerosed roots there are many congested vessels. The walls of these vessels, however, present no marked abnormality.

Microscopic examination of brain.—Marked degeneration of fronto-occipital and fronto-temporal association fibres, atrophy of superficial cell layers of cortex in pre-frontal and fronto-central regions, slight glia cell proliferation, only small amount of vascular change. Atrophy of tangential and supraradial fibres in same situations.

- Case 43.—Tabes of four years standing, then a congestive seizure, followed by transitory aphasia and slowly progressive dementia.
- R. B., aged 50, admitted to Colney Hatch, September 12, 1900. Ticket of leave man, sent from Pentonville, single, occupation tailor, working as a sewing machinist, previously in the

Marines. Admits having had a sore on the penis, which gave him no pain, and he was not treated. Lymphatic glands generally enlarged, papery scars over chest and abdomen.

History of illness.—Four years ago had a cord-like feeling round the waist, he has drunk heavily at times, but there is no marked history of alcoholism.

Family history not obtainable from friends, as he has no visitors. He himself is unable to give any satisfactory data. He was transferred from Pentonville with a certificate, indicating that he had had a congestive seizure, followed by transitory aphasia, with dementia, and wet and dirty habits.

Mental condition.—He has no actual delusions, he is a little incoherent in his answers, but can give a fairly intelligible account of his past life, although his memory as to place and time is defective, for he does not know the year, nor the month, but he was able to tell me that he was in the Marines, and that he had been in Pentonville prison, where he was sent for having stolen a piece of meat. He can hardly do simple multiplication sums, and if able to give a correct answer, he is quite lost when the figures are reversed.

Physical condition.—There is a loss of expression of the face, especially of the right side, the right grasp is a little feebler than the left. The speech is very slightly hesitant, no tremor of tongue or lips. He has a very ataxic walk, and he cannot stand with his eyes shut. He has pain in his legs, which he thought were rheumatic; he has suffered with them for twelve months, and thought that they were due to the machine work. Right pupil irregular, rather smaller than the left (3mm.), inactive to light, they react to accommodation. He has some loss of sense of position in the hands and feet, he can correctly locate light tactile sensations, and he recognises the prick of a pin over the whole body. The leg can be raised to a right angle with the body, indicating a fair amount of hypotonus. The knee-jerks are absent on both sides. Examination of the fundus reveals nothing abnormal on either side.

June, 1901.—There is very little change in the condition of this patient. He is somewhat thinner, but his mental condition has not altered for better or worse. He walks more unsteadily and there is a tendency to fall to the right. The tongue is more tremulous and protrudes towards the right slightly. The pupils are unequal, the right $3\frac{1}{2}$ mm. irregular, the left 3 mm., also irregular, inactive to light, react sluggishly to accommodation.

Case 44.—Tabes eleven years after infection. Ataxy, sensory disturbance, bladder disturbances, history of monetary troubles, development of mental symptoms, disappearance of spinal symptoms in great measure. Knee-jerks absent on admission to asylum. Mental and physical improvement. Relapse, development of left-sided seizures terminating in hemiparesis without any contraction. Reappearance of knee-jerk on left side. Attack of dysentery, recovery. Attacks of vomiting (probably crises). Further left-sided seizures spreading to right side. Death two years after onset of mental symptoms. Right hemisphere 17½ ozs. Left 19¾ ozs. Naked eye gray degeneration of posterior columns of spinal cord, also of pyramidal track on left side in dorsal and lumbar regions.

W. H., college porter, Guy's Hospital, aged 38. Married, two children, and two miscarriages; contracted syphilis in 1888, for which he was well treated. No history of insanity in the family, not intemperate. In May, 1899, complained of pains in the legs and unsteadiness of gait. He was admitted into Guy's Hospital under Dr. Pitt, to whom I am indebted for the following notes. Pains in the lower extremities, in the bones and muscles rather than in the joints. He complained of unsteadiness in walking, and he noticed diminution of sensibility across the buttocks and scrotum, and along the inner sides of the thighs. Thinks when he is sitting down that he is on a pole 3ins. in diameter. Marked ataxic gait, even with eyes open. Cannot stand with feet together and eyes shut. Knee-jerks absent. Plantar reflexes absent, abdominal present. Impaired sensation of soles of feet and inner sides of thighs. Pupils equal, small A.R. Speech normal. At times depressed, memory and intelligence good. Frequently he has difficulty in starting micturition, and is troubled with constipation. Frenkel's treatment applied with benefit; discharged in unchanged condition.

His wife relates that he had saved £350 in eleven years, and he lent some of it to a friend who did not repay him, and this caused him great worry and anxiety, followed by sleeplessness and depression; his mind became affected, and he was admitted to Bethlehem in September, 1902, and to Cane Hill Asylum, December 31, 1900. His condition in February, 1901, was as follows:—

Physical condition.—Facial expression denotes mental enfeeblement; there is some obliteration of the lines of expression, especially on the left side. The left eye is rather more open than the right. There is marked tremor of the tongue and lips, and staccato speech; there is more tremor on the left than the right side. Right pupil, 2 mm., left, $2\frac{2}{3}$ mm.; right, accommodation to $1\frac{2}{3}$, and left to 2. No reaction to light or pain. Gait slightly unsteady and incoordinate, rather a wide base, no stamping of feet, no Romberg symptom, no definite area of affection of cutaneous sensibility to pain or touch anywhere (answers quite reliable); sometimes confuses a touch with a prick. No loss of sense of position of joints. A needle introduced deeply into the muscles of the legs in different regions, and the patient made to move the muscles, exhibited a loss of muscular sense. Plantar reflexes normal, all other superficial reflexes brisk. Knee-jerks, and triceps-jerks absent, hypotonus of hamstring muscles extreme (30 degrees beyond the vertical). No crises, no loss of control of sphincters, and no difficulty now with the bladder or bowels.

Mental state.—Very emotional, readily laughs or cries. Marked bien être, weak-minded and childish in conversation. Comprehension fairly good, likewise orientation. He can give a fairly good account of his past life, and he has no delusions, illusions, or hallucinations.

For some time he improved both mentally and physically, then in April, 1902, he suffered with left-sided seizures and vomiting, which preceded an attack of acute dysentery; blood and slime in stools, pyrexia and distended tender abdomen. It was a month before the acute symptoms subsided, and two months before he was convalencent. During this period of convalencence he suffered with paroxysmal attacks of vomiting (crises?) on several occasions. In August he was much more demented, and was the subject of many epileptiform seizures, mainly affecting the left side, leaving him in a nearly hemiplegic condition; whether he was hemianæsthetic could not be determined, as he did not speak when questioned.

The left knee-jerk was now obtainable, the right still absent.

August 29.—He commenced a succession of epileptiform seizures affecting especially the left side (head and eyes turned to the left). Temperature subnormal. August 31.—The convulsions on left side ceased, the limbs were flaccid and helpless. Convulsive spasms of the right side now occurred, conjugate deviation of head and eyes to the right. Temperature 100.6°, quite unconscious; death supervened on September 1.

Autopsy (abstract).—No scar on penis or glands or signs of syphilis on the body. All the viscera were apparently healthy, with the following exceptions. *Heart.*—12 ozs., cavities dilated, stopped in diastole, muscular substance greasy and friable. No

valvular disease. Lungs.—Healthy, excepting hypostatic pneumonia of both bases. All the abdominal organs, like the thoracic, showed signs of congestion, the result of asphyxia from prolonged seizures. Throughout the large intestine there was evidence of the attack of dysentery from which he had suffered. The mucous membrane was thin, and showed white lines and small patches indicating scar tissue, the solitary follicles were in many places prominent, but everywhere the condition denoted that a healing process had occurred, and there were no signs of recent affection of the internal coats of the bowel. Brain.—Excess of fluid, marked thickening of pia-arachnoid, especially over frontocentral convolutions, great wasting of right hemisphere. Weight, right, 17½ ozs. Left 19¾ ozs. Great dilatation of right ventricle, especially in posterior part, due to atrophy of brain substance, forming floor and outer wall ependyma granular. Convolution, pattern complex and good. Brain kept for investigation, fourth ventricle very granular. Spinal cord, obvious atrophy of posterior roots, and gray degeneration of posterior columns extending from the seventh and eighth cervical segment downwards. Degeneration of left crossed pyramidal tract in lower dorsal and lumbar Examination of blood contained in the femoral vein showed a great abundance of choline.

Microscopical examination.—Brain exhibited marked cell and fibre atrophy, glia proliferation, and vascular changes, with plasma cells.

- Case 45.—Tabes of four years duration in a man aged 55. Arteriosclerosis affecting the small cerebral arteries especially, marked atrophy of the right hemisphere, with multiple miliary softenings, left hemianæsthesia, and hemianopsy.
- C. C. Occupation, labourer and turner at the Arsenal; afterwards railway porter, and for thirty years a signalman. Aged 55. Married twenty-seven years, no children; wife had two premature births. Drank somewhat when a porter, but not recently. His symptoms began three or four years ago; he noticed difficulty in passing his water, which ran slowly, and he continually wanted to go, but the urine only dribbled away; also, he had difficulty with his bowels, and shooting rheumatic pains in the left leg. He gives a history of having had a sore on his penis four years before marriage. He was treated for three or four months at the Royal Free Hospital. He had secondary symptoms, sore throat, rash and hair falling out. He was admitted to Cane Hill Asylum with delusions of persecution. No insanity in the family.

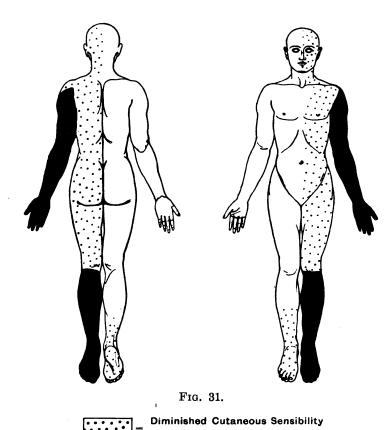
On October 4, 1900, he had an epileptiform seizure, which left him in an incoherent mental condition, and he could give no rational account of himself.

Physical condition (October, 9, 1900).—He is in fair state of nutrition, and was able to give a good account of himself and his illness, which I subsequently found reliable. He is a well-built man with several papery scars over the back. He has an ataxic gait, the left foot and leg being most affected. The knee-jerks are absent on both sides even with reinforcement. There is marked hypotonus in both legs. Romberg's symptom is present; he has not suffered with any crises, and he complains of no visceral symptoms, except the difficulty of making water. The pupils are equal, perhaps the right a little larger than the left (2½mms.), inactive to light, react to accommodation. He has complained of imperfect vision in the left eye, and tested roughly, he is found to have left-sided hemianopy. He has had one left-sided epileptiform seizure since he has been in. He says sometimes he will wake up and not know that he has a left leg and hand. He has been unable on account of the numbness to button his clothes with his left hand for four or five months. There is great incoordination in movements performed with the left hand. He cannot touch the tip of the nose, but he can do it with the right hand. He says he cannot feel his moustache with his left hand. but he tells me of his own accord that he has no loss of power, and he certainly has a good grasp. His sensation was tested, and the accompanying charts indicate the condition found. It may be remarked, however, that although it took one hour and a half to make these charts, they can only be considered approximately true, for, as in all cases, response to stimulus varies; but subsequent notes made by Dr. Gilfillan show a marked difference in sensibility on the two sides of the body. Very possibly, the hemianæsthetic condition may vary in degree according to variable conditions of the opposite hemisphere, but the post-mortem results absolutely accord with this condition. I saw the patient several times subsequently. I did not notice any speech affection or tremor of the lips and tongue, and I looked upon the disease as a case of tabes with mental symptoms. There was only a very mild degree of dementia, his knowledge of time and place and memory for ordinary events of his past life seemed fairly good. The attendant states that he is dull, confused and incoherent after he has had fits.

December 15, 1900.—Had a slight seizure on November 30, followed by increased weakness of left leg. Had a seizure on

December 13, and another to-day, affecting his left side. Is now confined to bed.

February, 1901.—Knee-jerks absent. Plantar reflexes exaggerated. Left leg paralysed, left arm weak (patient says it is senseless). Sensation right side good, whenever roughly touched on left leg, refers touch to inner side of thigh; touched on left arm, refers touch to point of shoulder. Complains of pain and numb-



ness of left leg. Pain in left hip shooting down to knee and calf. Pain during passive movement of left leg.

to Pain and Touch

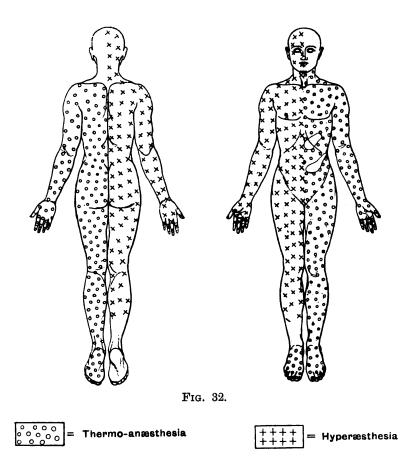
Analgesia and Anæsthesia

Girdle pains when up, never in bed. Shooting pains in left arm. Pupils equal. Left reacts to light sluggishly, both to accommodation. Tongue steady. Right side distinguishes hot and cold. Left side cold resembles pricking, and hot not recognised. (Dr. Gilfillan.)

March 21, 1901.—Had a seizure to-day affecting the left side. April 17.—Has marked dulness over left lung, and impaired breath sounds. Temperature hectic in type. Feeble health.

May 1, 1901.—Small râles can be heard over both lower lobes, but the sounds are muffled in the left. Is rapidly becoming much worse.

May 7.—Gradually sank and died.



Cause of death as certified.—General paralysis of the insane. Tubercular broncho-pneumonia.

Abstract of post-mortem notes: Body well developed and well nourished, except thighs and legs, which are wasted and flabby; a large amount of subcutaneous fat present in all parts of the body. No marks of syphilis. Skull.—Nothing abnormal. Membranes.—Dura mater thickened and firmly adherent to skull

along the vertex. Pia-arachnoid extremely opaque, much thickened, chiefly in frontal, central, and parietal regions. places it is somewhat maroon coloured, probably the result of old, slight hæmorrhages. The membrane strips readily without causing decortication. Pacchionian bodies are very large. Spaces.—Subdural contains excess of clear fluid; sub-arachnoid, excess of fluid, which is slightly blood tinged. Brain.—The left hemisphere weighs 4 ozs. more than the right; the convolutions of the right hemisphere are of normal complexity, but markedly atrophied, especially in the frontal and central regions, the sulci here being wide and deep, containing considerable excess of fluid. The ventricles are slightly dilated, and studded with a few small granulations. The vessels, especially the branches of the carotids, are studded with numerous atheromatous plaques. The sinuses are healthy. The fourth ventricle is granular, but the cerebellum, pons and medulla, show no naked eye change. The general appearance of the right hemisphere of the brain is characteristic of general paralysis, the left to a much less degree, but vide description after hardening in Formol. Considerable excess of cerbro-spinal fluid. The left hemisphere weighed 600 grams, the right 490 grams, preserved for further examination. Extensive leptomeningitis affecting the posterior surface of the spinal cord, especially in the dorsal region. There is naked eye gray degeneration of the posterior columns in the lumbar and dorsal regions. The patient died from extensive tubercular bronchopneumonia. The brain and spinal cord were hardened in Formol-Müller solution, and then sliced up and examined. There was no naked eye foci of softening to account for the atrophy of the right hemisphere. Convolutions were much smaller on the right than the left side, and showed a considerable diminution of the gray matter of the cortex of the frontal, central, parietal, and temporal regions, where there was very marked thickening of the piaarachnoid. The right lateral ventricle was markedly dilated, especially in the posterior part, and extended farther back than the left.

Microscopical examination.—By Nissl, Marchi, and Weigert methods demonstrated the following facts. There was a random degenerative process due to vascular changes, which was the principal cause in the difference of weight in the hemispheres. The fact that no gross change could be seen, and yet there was so much atrophy, accords with the microscopic observation of numerous scattered miliary areas of softening in the white matter immediately subjacent to the gray cortex, affecting especially the

radial fibres of the ascending parietal, and the optic radiations about the calcarine fissure. Sections through the ascending parietal and ascending frontal show a gross old degenerative change of the ascending parietal. This accords with the fact that there was a hemianæsthesia without much loss of power when I saw him. Later, no doubt, there was extensive destruction of the ascending frontal, or more likely some part of the path of the fibres on their way to form the pyramids of the medulla, for the left pyramid presented a naked eye atrophic sclerosis, likewise the right direct pyramidal tract. The spinal cord also showed atrophic sclerosis in the usual situation in the posterior column of a fairly advanced case of tabes. The miliary softenings in the brain show the following characteristics: dilated congested vessels with hæmorrhages into the lymphatic sheaths, accompanied by endothelial cell proliferation lymphocytes and plasma cells (vide Plate VIII., fig. 2). Many of the larger neoplastic cells contain pigment derived from the blood in various stages of disintegra-In the neighbourhood of these vascular changes, which often have a dendritic form are seen ganglion cells undergoing acute degenerative changes. The miliary softenings are much more numerous in portions of the right hemisphere in various situations than in the left. They seldom affect the superficial layers of the cortex, hence in many regions where there is a very extensive destruction of the radiating fibres there is less destruction than one would expect of the tangential and superradial fibres. The affection of the right hemisphere and the fact that the superficial fibres of the cortex were not much affected may account for the comparatively slight dementia he suffered with, as compared with the amount of brain destruction.

Case 46.—Publican, formerly policeman, suffered five years with progressive tabes, development of mental symptoms, becoming lustful, suspicious, extravagant, and dangerous to himself and others. Speech affection developed, progressive dementia with intervals of improvement, epileptiform seizures, death. Advanced tabic lesion of the cord, chronic and acute degenerative changes of the brain. Heterotopia spinalis.

W. A. McSt., publican, aged 42. Married; no children. At 17 joined the Guards, served eight years, became colour-sergeant. While in the army had gonorrhœa and sore. At 25 joined the police force, served thirteen years, invalided with locomotor ataxy. First symptom noticed was sudden loss of power in his

legs, while serving notices as a jailor. After this suffered with pains in his legs and girdle sensations, no bladder trouble until recently; he has not suffered with headache nor any visceral crises, does not complain of his food.

Physical condition.—Ataxic gait, Romberg's symptom marked, triceps and knee-jerks lost, some loss of sense of position in hands. Right pupil 4 mm., left 5 mm., irregular, and neither react to light, but sluggishly to accommodation. He stands with a wide base and with the support of a stick. He has some difficulty in maintaining his position on the polished floor, and he finds a special difficulty in rising from a sitting posture. He has a typical ataxic walk, the body being bent forward, the neck stiff, but slightly inclined down, so that he can watch and control the movements of his legs. The advancing leg is extended at the knee instead of being flexed, jerked forwards and outwards at the hip, the heel being brought down with a stamping action.

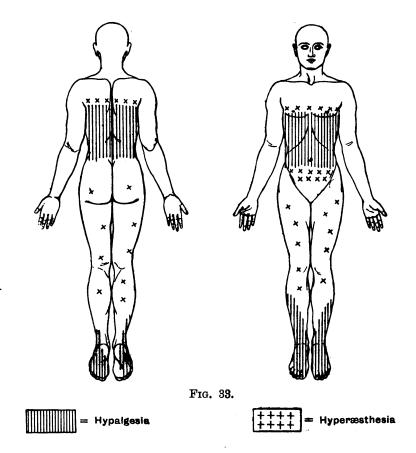
Expression.—He has a depressed and anxious look when not engaged in conversation, but he is easily moved to tears or laughter. When speaking there is a marked tremor in the lips noticed, and there is a tremor in the tongue on protrusion. His speech, like his handwriting, is hesitant, tremulous, and many of the syllables are slurred.

Skin sensibility.—Over the thorax, from the sixth to the tenth segments inclusive, there is a loss of sensibility to light tactile impressions. Above and below this region, he feels light tactile sensations, but there is often some confusion as to localisation. and on the peroneal surface of the legs and the soles and dorsal surfaces of the feet, light tactile sensibility is considerably diminished, and often the stimulus is either not felt or incorrectly localised in these regions. Painful sensation is blunted considerably over similar regions to those in which tactile sensibility was impaired or lost. Very often there was a considerable delay (two or three seconds) before he responded to the stimulus. In the regions above and below the areas of analgesia pricking seemed to cause unusual burning pain, so that there was hyperæsthesia over the inner side of the leg and thighs and lower part of the abdomen. I could detect no thermal-anæsthesia over any part of the body (vide charts of sensory disturbances).

Reflexes.—Triceps and knee-jerks absent; superficial reflexes—plantar present, but not active, cremasteric present, fairly active. He has had no difficulty with his bowels or bladder, he has no loss of control. There is some degree of hypotonus, but not in proportion to the ataxy. The muscles are firm and strong, leg

extended can be brought to 90° with body. From his conversation, one would judge that he had suffered from satyriasis.

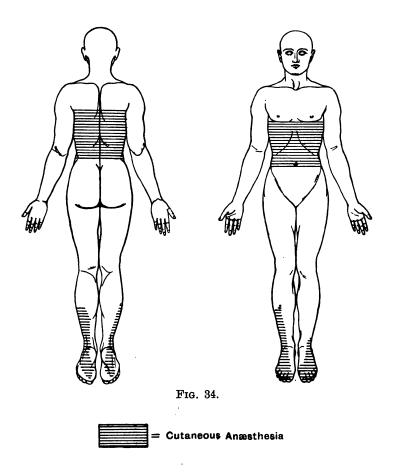
Vision.—No failure to recognise colours, he has recently complained of dimness of vision of the right eye. There is commencing optic atrophy, affecting especially the temporal half of the disc, and apparently some cupping, vessels normal, the fundus has a gray appearance in this situation, and the vessels are curved. There is no myopic crescent.



Mental condition.—He is able to converse on most subjects, and to give an account of his life, which accords fairly well with what his wife had told me. He has a fair knowledge of time and place, but he has delusions about his wife's fidelity or her father's accusations against him on this score. He has moderate grandiose delusions about his property, and what he can do when he gets out. From his conversation he has evidently been leading

a very loose and extravagant life, throwing his money away at music-halls and otherwise; still, one recognises that in all he says there is a certain amount of truth and reason mixed with folly and irrationality.

History (from wife and sister).—Wife had no children; she herself has good health, he was a good, kind, and affectionate husband. He suffered for five years with locomotor ataxy. Up till six months ago he was mentally quite right, then she noticed



he became lustful, irritable, sleepless, given to extravagance, and planning all manner of schemes; lately has become suspicious, jealous, and at times violent, threatening to murder people, and having delusions about his wife's fidelity. This is indicated in the letter which he has written, which shows both dementia and delusions, also characteristic tremor, and leaving out of words

and syllables. His wife noticed that since his mind became affected he had become much stronger in his legs. She made this remark without any leading question being put.

March 2, 1901.—He suddenly fell down, Dr. Bolton who saw him describes the fit that ensued as follows. Marked clonic spasms of the right side of the face, less marked to the left. Right arm lying still. Left arm occasionally moved, apparently voluntarily as the patient pointed towards his head. Then the right arm was convulsed and next the legs, the right being more affected than the left, a tonic left-sided spasm then occurred followed by clonic movements of the left leg and left arm, and later the right leg and right arm. The left arm next became straightened out and the left bent at a right angle, the left leg flexed and the right leg straight. This was followed by marked conjugate deviation of the head and eyes to the left, and the left side of the face became more convulsed than the right. Pupils measured 7 mm. There was no ataxy noticeable in these movements.

April 7, 1902.—Came to the laboratory. Mentally he is much freer of delusions. He appears in better physical health and the acute maniacal symptoms which he had on admission, accompanied by exaltation, have in great part subsided. He remembered me, and conversed fairly intelligibly. There is slight tremor in the lips and tongue, and his speech is somewhat syllabic and hesitant. He knows how long he has been at Claybury and the day of the month.

Physical condition.—He is still very ataxic, walks by the aid of a stick, with a wide base; knees extended, head looking forward and on to his feet, and stamping gait. Lying flat on his back on a couch it was noticed that he had partial footdrop both sides, due to weakness of the dorsal flexors; by an effort of attention even with his eyes closed he could dorsally flex the foot, but if his attention were taken away, the foot would fall back again. When told to flex the knee and hip simultaneously, the failure of the dorsal flexion was noticeable, when told of it he immediately tried to correct it, and this he could do by an effort of attention, but it was noticed that the correction did not come till after the flexion of the hip and knee had taken place, and an appreciable interval elapsed; owing to the fact that it was brought about entirely by cerebral impulses.

Sensation (subjective).—He complains of numbress on the soles of the feet, and when tested there is manifested some hypesthesia and hypalgesia of the feet on both sides. There is a

complete loss of sense of position in the toes and ankle joints, and also to some extent of the knee-joints. There is considerable hypotonus of the hamstrings on both sides.

Thoracic sensibility.—This seems to have changed somewhat since I last examined him. I can now find no definite anæsthesia of the left half of the thorax in front, corresponding with the anterior divisions of the roots, but over the posterior divisions I find loss of sensibility to light tactile impressions over the fourth to seventh segments. The right half of the thorax the same condition obtained posteriorly, but in front a very curious condition existed; either he did not feel at all light tactile impressions over the front of the chest, extending from the fourth to seventh segments, or if he were touched more heavily he invariably pointed to a corresponding point on the left side of the thorax, (allochiria). These observations were quite reliable. He does not now show any hyperæsthesia. The epigastric reflexes were present on both sides also the cremasteric. The plantar are absent, there is no marked incoordination in the hands, but there is some loss of sense of position in the joints. There is no impairment of tactile sensibility. The pupils measure, left 6 mm., right 5 mm. A week ago he had paresis of both external recti; this, however, is now passing off. Three weeks ago he had an attack of profuse diarrhoea which Dr. Bolton considered was of the nature of an intestinal crisis.

Patient improved and tried to make himself useful until July 15 when he had a succession of seizures which terminated fatally in twenty-four hours from commencement.

Post-mortem notes (abstracted).—Well nourished. Scar in region of frenum. Dura mater, intensely congested, otherwise natural. Subdural spaces.—Great excess of fluid, well over tentorium. Pia-arachnoid.—Considerable fronto-parietal milkiness and thickening, marked pial extravasations in the postero inferior part of the external surface of the right hemisphere, slight ditto left hemisphere. The whole encephalon is intensely congested. Weight 1,415 grammes. Right hemisphere 632 grammes, left 590 grammes. Left hemisphere more simply convoluted than right. Fourth ventricle.—Covered with very fine granulations, most marked in calamus. Heart. — Dilated and flabby. Valves.—Mitral shows slight atheroma. Coronary arteries.—A little early atheroma. Aorta and great vessels.—Marked atheroma in all stages, mixed calcareous and pearly fibrosis. Abdominal aorta.—Markedly atheromatus.

Cause of death.—Cardiac failure and general paralysis.

Microscopical examination (by Nissl method).—Brain, left hemisphere: First frontal.—Marked vascular congestion, perivascular lymphatics filled with proliferated plasma cells. Disordered Meyert's columns, acute cell changes; glia cell proliferation; all cortical layers affected. Vascular changes more marked in the deeper layers. Moderate increase of spider cells in superficial layers of cortex. Many of the small, and a fewer number of the medium sized pyramids, distorted in shape. The cell changes appear to be more marked in the polymorphic and granular cells of the deeper layers. Coloration of protoplasm of many of the cells suggests coagulation necrosis.

Second frontal.—Changes similar but very much less intense. There is obviously an association between the vascular and acute cell changes in the first frontal.

Lower part of ascending frontal and parietals and Broca.—The same changes as above, only more marked. The small and mediumseized pyramids are more affected. The perivascular lymphatic cell proliferation is very marked, especially in the deeper layers. The cells do not present the appearance of experimental anæmia produced by ligation of four arteries with recovery, but much more the appearance of a coagulation necrosis, such as is produced by toxic agents, a fatal dose of abrin or ligation of arteries without re-establishment of circulation. The protoplasm of the cells stains a uniform dull diffuse purplish blue, instead of a bright blue. The medium and small-sized pyramids in this respect, contrast with the large Betz cells, the majority of which show normal Nissl-granules. Pappenheim's stain shows abundance of plasma cells around vessels, and some are found in perineuronal spaces (vide figs. 3, 5, 6, Plate VIII.).

Top of ascending frontal.—Very little vascularity and congestion or perivascular cell proliferation. Small and medium sized pyramids deficient, much more so in some places than others. Betz cells numerous, the majority appear fairly normal. In some the nucleus is large, clear, and swollen, others show deficiency of chromophilous substance. The small and medium pyramids are distorted, and processes broken off.

Spinal cord.—Naked eye degeneration in usual situation and amount of the sclerosis corresponds with the second stage of ataxy in the cervico-dorsal and lumbo-sacral regions. Gray matter, lumbo-sacral region; marked vascular stasis probably associated with epileptiform seizures. No great excess of leucocytes around vessels or in contained blood. Neuroglia cells, small variety in abundance. Ganglion cells of anterior and posterior horn, apparently normal in numbers. Anterior horn cells are

rather swollen (probably acute change from venous congestion), nucleus large and clear. Nissl-granules in cytoplasm, and in processes fairly abundant and normal in tint and shape. Cells of base of posterior horn and substantia gelat. apparently in numbers normal. I am unable to judge whether the protoplasm of the cells is normal. The slight cell changes that exist are probably due to the venous congestion occasioned by the seizures in which he died. The glia cells of the degenerated posterior columns are mostly small round or oval, there are some few Deiter's cells more than elsewhere, also granulation corpuscles and excess of glia fibrils.

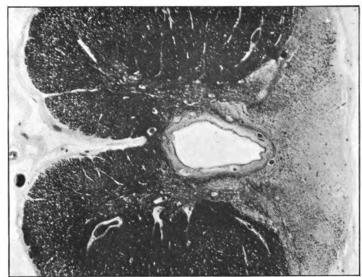
Microscopical examination of the central nervous system for acute degeneration (by Marchi method).—Cerebrum.—Various portions of the brain which were examined by Nissl method were also examined by the Marchi method; no recent degeneration was found in the superficial layers of the cortex. A considerable number of degenerated radial-fibres were found in the ascending parietal, but very few in the ascending frontal. This accords with the fact that very few degenerate fibres were found in the pyramids of the medulla oblongata and in the antero-lateral columns of the cord. In the medulla a well-marked degeneration was found in both ascending branches of the fifth nerve, there was considerable vascular congestion and numbers of black points due to degenerated collaterals in the cranial nuclei of the fourth ventricle, and the cells of many of the nuclei were stained black. That the degeneration of the ascending branches of the fifth nerve was genuine was shown by the fact that the adjacent restiform bodies were quite free of black particles and granulation corpuscles.

The spinal cord exhibited very little recent degeneration, but the fifth cervical segment showed a number of recently degenerated fibres on one side in the postero-external column, especially in the cornu-radicular and root zones. This to a less extent was seen in the remainder of the cervical segments below the fifth. The examination of the dorsal segments showed a marked dilatation of the central canal, normal epithelium lining the whole canal, and, therefore, it was a true heterotopia (vide Plate IV.). Around the dilated canal were proliferating, round glia cells. Both the epithelium cells lining the central canal and the glia cells are filled with black granules, products of degeneration, thus showing that they have an active phagocytic function. A further description of the epithelial and glia proliferation is given on p. 293.

Microscopical examination for chronic degeneration (by Weigert

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PLATE IV.



postero-external tracts respectively, and are in all probability endogenous in origin. Magnification 8 diameters. epithelium. The column of Clarke lies on each side, it is oval shaped; the fibre plexus is absent, but bounding it internally and externally are two tracts of fibres, which proceed back from the base of the anterior horn to the cornu-commissural and Dilated central canal lined with columnar

the fibres of the posterior column are for the most part destroyed, yet the posterior column bulges backwards beyond the normal; usually when there

proliferation, for although

Heterotopia spinalis seventh dorsal segment.

irregular dilated central canal lined by

ciliated epithelium is shown. very marked glia cell

The irregular

is such advanced tabes as this the posterior column is flattened and retracted. Magnification 8 diameters

TABES IN ASYLUM AND HOSPITAL PRACTICE.

To face p. 185.

and Marchi-Pal methods).—The same regions of the brain were examined, and a marked atrophy of the tangential and supraradial fibres was found in the ascending frontal and second frontal, very much less in the ascending parietal. There was complete loss of these fibres in the orbital and prefrontal convolutions, and in these regions there were a large number of branching glia cells.

Spinal cord.—There was very marked degeneration of the root fibres and their intramedullary projections extending from the fourth cervical downwards to the termination of the cord, but the degeneration was most advanced in the lumbo-sacral and mid-thoracic regions. The endogenous fibres were in this case markedly affected, there was a great diminution of the fibres of the comma tract, the posterior internal zone, septo-marginal tract, and the oval area of Flechsig, likewise the small median triangle of the sacral region. A considerable number of fibres have disappeared from the cornu commissural zone and been replaced by glia tissue, but this portion of the posterior column is the least affected. Owing to the heterotopia in the dorsal region, the course of the endogenous fibres can be more distinctly seen than in other spinal cords of an equally advanced degree of tabes, with posterior column atrophy and sclerosis. Fibres can be distinctly seen passing from the base of the posterior horn round Clarke's column to form the posterior commissure, decussating with similar fibres from the opposite side. These fibres are of endogenous origin, as they are of fine texture, and can be seen starting from the region mentioned, while the fibres of the root zone are entirely absent, and therefore cannot give origin to them (vide fig. 2, Plate IV.).

Teased preparations of the posterior roots attached to the third, fourth, fifth, sixth, seventh, and eighth cervical segments were made. The root-fibres of the third segment were mostly small or medium-sized medullated fibres; they showed no neurilemmal nuclear proliferation. The roots of the fifth showed a number of large medullated fibres with well-developed myelin sheath, and no nuclear proliferation, but there were also a large number which showed the myelin sheath in various degrees, attenuated, and these exhibited a marked nuclear proliferation of the neurilemma. Again, in some there was complete absence of the myelin, and apparently only the neurilemma, the cells of which had undergone marked proliferation, was left. Below this level the rootlets contained only a few solitary myelinated fibres, and in these the sheath was much attenuated.

Case 47.—Tabo-paralysis, grandiose delusions, ataxy. Duration of disease said to be one year.

W. J. W. Occupation, labourer. Aged 31. Admitted to Claybury Asylum, November 18, 1895, under the following certificate: "He is strange in his manner, and varied in his moods. At one time he is depressed and pre-occupied, and at another laughs, sings, and whistles. Declares he is a great fighting man, and states that he is the possessor of a gold belt worth £11,000, awarded to him for his successes as a pugilist. He also asserts that he has been a soldier in India, and has fought many battles, and has obtained three medals for the same (although I am informed that he has never been abroad). He further tells me that he is going to buy some land and build houses upon it, which he proposes to let free of charge to the poor. He is wet and dirty in his habits, and his memory is is impaired."

Condition on admission.—Pupils equal. A. R. irregular, gait ataxic, knee-jerks abolished. Scar on penis. Symptoms commenced seven months before admission, probably the cord symptoms of longer duration.

Mental condition.—As above. He is irrational and incoherent. December 7, 1895.—He is noisy night and day, very mischievous, pulls himself up by the blind cord. Grandiose delusions persist.

January 15, 1896.—Advanced general paralytic. He has had one or two slight seizures. He is very paretic, and in poor general health and condition.

February 8, 1896.—Died of exhaustion of general paralysis.

Autopsy.—Convolutions of the brain are well formed, and are not wasted; the pia-arachnoid is slightly thickened, but it is not adherent to brain substance. Lateral ventricles are normal, the fourth is dilated and slightly granular in its lower part. The posterior columns of the spinal cord are wasted; the aorta is slightly atheromatous at its base. There is hypostatic congestion of the bases of both lungs. On the penis there is an old scar.

Microscopical examination.—First frontal convolution showed some early changes characteristic of dementia-paralytica. The tangential and supraradial fibres were greatly diminished, some increased vascularity, atrophy and changes of the superficial pyramidal cells, and distortion of Meynert's column.

Spinal cord.—The cervical, thoracic, and lumbo-sacral regions showed advanced sclerosis and atrophy of fibres in the usual situations. There is some atrophy of the endogenous systems.

the least to be affected being the cornu commissural zone. The posterior roots are markedly atrophied, only a few myelinated fibres being left in the lumbo-sacral regions (vide fig. 39). In the lateral and anterior columns there are diffuse scattered degenerated fibres, but there is no sclerosis. There is marked vascular congestion throughout the cord and medulla. In the sclerosed areas there is an obvious thickening of the vessel walls. The appearances of the cord lesions would indicate tabes of some years standing. The notes which are taken from the case book are too brief to be of much value.

Case 48.—Tabes of four years' duration, onset of mental symptoms of general paralysis, admission to asylum, epileptiform seizures, attacks of vomiting, death about one year later.

W. T., aged 38, single, tinsmith, under the care of Dr. Head, to whom I am obliged for allowing me to make an abstract of his notes. Admitted to London Hospital June 5, 1897.

Personal history.—Chancre at 22, which ate away the frenum, followed by repeated ulcerated throats, noticed no rash. He has had pains in his legs and stomach for eighteen months. Last year he had double vision, which lasted six months before it began to improve. Very tired when walking, no difficulty with his bladder, except that he cannot hold his water so long as he used to be able to. About eighteen months ago he became lustful, very different from what he had been before. He had plenty of power, but for the last six months he has become very feeble, but desire is still present, but erection fails. No trouble with the rectum, or other illnesses. He has always earned good wages, has drunk a good quantity, but never enough to incapacitate him. There is nothing noteworthy in his family history, with the exception that one brother is asthmatic.

Nervous system.—Speech good, no attacks or fits, no headache, stands perfectly steady, with the feet together and the eyes open. With his boots on and his eyes shut, no swaying movement is noticed, but these come on when he takes his boots off. He can rise from toes to heels quite easily with his eyes open, but he tends to fall forwards when his eyes are closed. Very slight incoordination of left hand, with eyes shut on touching the nose, no paresis. He complains of rheumatic pains in both knees, a tired, aching feeling, but not shooting pains. Cutaneous sensations in all forms both in time and place are excellent. Knee-jerks are present on both sides without reinforcement, the right greater than left. On a previous occasion the left

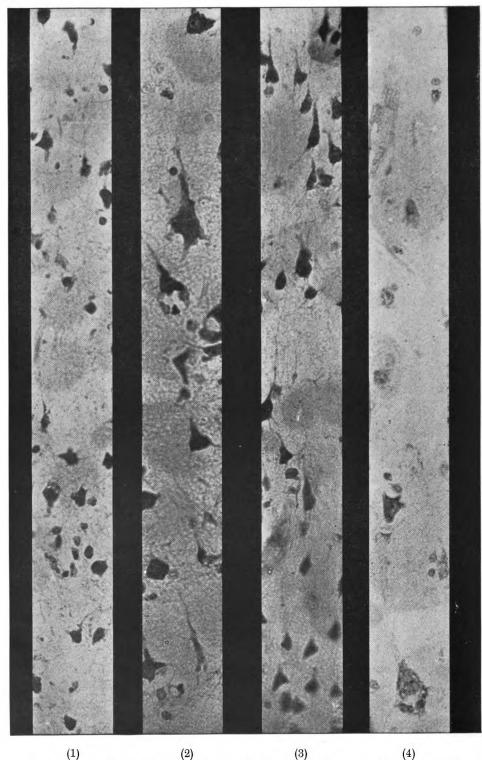
could not be obtained without reinforcement. Plantar and abdominal reflexes good. Pupils equal, 2 mm., Argyll-Robertson phenomenon. Paresis of right external rectus. Face movements good, no tremor of tongue, sphincters normal. Perimeter tracings showed considerable concentric limitation of field of vision. He attended as one of Dr. Head's out-patients until June 24, 1899. He then disappeared, and was admitted into Bexley Asylum. When I saw him he was suffering with symptoms of general paralysis. The speech was slightly slurred, the tongue tremulous, also the face muscles; there is an expression of mild exaltation, but he is able to answer questions and give a history of his occupation and illness which corresponded fairly well with the account contained in Dr. Head's notes. There is, however, some defect in his knowledge of time and place, but no pronounced delusions were discoverable. He now has some bladder trouble, diminished sensation to pain in the lower extremities; the trunk was not tested, muscular hypotonus in addition to the symptoms of ataxy previously noticed. He became progressively more demented, but rather tended to childishness than absolute loss of intelligence.

On October 12, 1900, he commenced having epileptiform seizures, and he was found by Dr. Piper convulsed on both sides and in a state of opisthotonus, his temperature was 102°, and he was sweating profusely. He was first in a comatose and afterwards in a semi-comatose condition. He had a large number of seizures of a similar character, but affecting especially the left side, and on October 15, it is noted that he had twenty-two seizures since October 12.

October 22.—It is noted that his tactile sensation was thoroughly tested, no alteration was detected, and there was certainly no hemianæsthesia present. The note further states he is now quiet, and can answer intelligently when spoken to. His memory is considerably impaired, and he often becomes confused in conversation. He passes his water naturally, and has control of his motions. No important change occurred, but progressive mental and bodily enfeeblement until February 9, when he commenced having a series of convulsions, and it is still noted that there is no hemianæsthesia.

On February 28, he commenced having attacks of vomiting, which continued for more than a week, associated with retention of urine, which persisted after the vomiting had ceased.

On March 21, the notes state "he was transferred yesterday to the general paralysis infirmary for the purposes of better classi-



Photomicrograph of strips of the brain which are from left to right. (1) Small and medium sized pyramidal layer, top of ascending frontal, showing abolition of Meynert's columns produced by destruction and distortion of the pyramids. Not a healthy cell is seen. There is a marked proliferation of glia cells. (2) The same section of the cortex in the deeper layer of large pyramids. Two Betz cells are seen together, one is obviously destroyed and has been partially devoured by phagocytes. Most of the cells are abnormal. (3) Pyramidal layers of occipital cortex. Both as to numbers and conformation they present a comparatively normal appearance. (4) Broca's convolution. Very marked destruction of medium sized pyramids shown.

To face p. 189.

fication." He is still sick at intervals; mentally he is very demented, but quite happy. He vomited at intervals up to his death on April 6.

Post-mortem examination.—Showed little in the organs of the body except in the brain and spinal cord, but it may be noted that there was an old calcareous nodule at the apex of the left lung, some emphysema of both lungs, a moderate amount of atheroma of the aorta, and considerable chronic cystitis.

Brain.—Weight of right hemisphere, 518 grammes; weight of left hemisphere, 542 grammes. Granulation of the third and fourth ventricles, dilatation of all ventricles, left lateral ventricle less than the right. Pia-arachnoid adherent in pre-frontal region mid-line, leaving erosions on stripping. External appearances of hemispheres.—Right: Obvious wasting of base of first frontal and base of inferior frontal at junction of acending frontal. Left: appears less wasted as a whole, but there is a small triangular depression due to atrophy just above the angular gyrus: appearance of gray matter of cortex is somewhat wasted, but wasting is not universal. Striation in many places indistinct. Same applies to right side.

Notes of the microscopical examination of the central nervous system.—Nissl staining of the cortex.—The small and medium sized pyramids show their processes broken off; the apical processes are either not present or cork screw. The cyto-plasm stains diffusely and imperfectly; the nucleus is often eccentric. The columnar arrangement of the cells of Meynert's layers has disappeared. The small cells of the molecular layer and the small pyramids are especially affected in the first frontal, ascending-frontal, ascending-parietal, and Broca's convolutions, but to a less degree in the occipital. The large Betz cells of the ascending frontal occur in groups, some of which appear quite normal, others show chromolytic changes, swelling of nucleus, and breaking off of processes, and some exhibit excess of yellowish pigment.

The medium and small-sized pyramids are much more affected in these regions than in the occipital lobe (vide Plate V.).

As a rule the vascular changes are not pronounced, but many small veins in all regions of the cortex show, the perivascular lymphatics filled with basophil staining cells; there is not excessive glia cell proliferation.

Spinal cord, stained by Weigert method (each segment being examined)—Cauda equina and fifth sacral. All the posterior roots are atrophied, and almost totally denuded of fibres; some few atrophied myelinated fibres can be seen in some of the roots.

The vessels are congested, but the walls are not thickened, and they are obviously distended with blood merely from ante-mortem stasis, for the anterior roots, which are quite normal, contain vessels similarly gorged with blood. Third sacral and roots.-Roots same as above. Posterior column sclerosis, and almost complete denudation of fibres, except in area corresponding to the anterior two-thirds of the portion of the posterior column surrounding the posterior median fissure; behind this up to the periphery there are scattered fibres corresponding, doubtless, to the endogenous fibres belonging to the oval area of Flechsig. Second sacral and roots.-Posterior roots markedly degenerated, but contain some fibres (large) undegenerated. The whole posterior column is partly denuded of fibres, except the median oval area and the cornu commissural zone. The degeneration is most marked in the root zone, and in the zone between the two undegenerated endogenous tracts (fibres of Goll's column). Crossed pyramidal tracts, both sides degenerated. First sacral.—The roots are entirely devoid of fibres, and the whole of the posterior column is sclerosed and denuded of fibres. The cornu commissural zone and oval area are the only tracts which contain fibres, and here they are relatively abundant. Fifth lumbar.—Posterior roots not nearly so much affected as first sacral, roughly speaking, quite one-third of the fibres still left. Degeneration in the same regions as the last, but a proportional increase to the numbers in the roots of fibres entering the posterior columns. Fourth lumbar.—Ditto, with regard to fibres in roots, except the two endogenous tracts are being separated by the degenerated areas corresponding to a tract which intervenes and approximates at the middle line, separating thus the fibres of the oval area, which are pushed backwards, although there are still a number of fibres scattered in the degenerated area. The crossed pyramidal tract is seen to be more degenerated in the left than the right side; the posterior column degeneration is about equal on the two sides, and in the median line extends forwards to the posterior commissure. Third lumbar.—Ditto, atrophy of fibres of the posterior roots, otherwise the same as fourth. lumbar.—Ditto. Here is seen commencement of Clarke's column, and there is some atrophy of the entering roots and of the fine plexus, but it is not marked. There is less atrophy of fibres of the posterior roots. First lumbar.—Ditto, but the atrophy of the feltwort of fibres around the cells of Clarke's column is very evident as the column is more developed; the encircling tracts of endogenous fibres are, however, relatively abundant.

dorsal.—Roots much smaller, less number of degenerated fibres, vet very marked atrophy of fibres entering Clarke's column, and of the plexus of fibres; most marked degeneration in root zone and area extending thence to mid line; slight degeneration of Lissauer's tract, moderate of postero-external triangle. Eleventh dorsal.— Posterior roots much less affected. Less atrophy of root zone and of fibres entering Clarke's column, also of other short tracts, e.g., Tenth dorsal.—Ditto; attached roots show very little Lissauer's. degeneration. Ninth dorsal.—Roots of one side almost denuded of fibres, and the postero-external column and posterior horn of the same side considerably shrunken. Eighth dorsal.—Ditto. The crossed pyramidal sclerosis is becoming less obvious, and above this level is no longer recognisable by the naked eye, although microscopically a little diffuse sclerosis can be found on one side as high as the sixth dorsal. Seventh dorsal.—The posterior roots are partially but equally affected on both Lissauer's tracts are very little affected at this level. Sixth dorsal.—The posterior roots are much more affected on the right side than the left. Fifth dorsal.—Roots completely atrophied both sides; both coarse and fine entering-fibres disappeared. Fourth dorsal.—Ditto. Third dorsal.—Roots atrophied both sides, one side more completely. Second dorsal.—Ditto. First dorsal.—The roots now contain a considerable number of healthy fibres, and the cornu radicular zone and the entering zone of Lissauer show very little sclerosis; still there is a great amount of atrophic sclerosis in the posterior columns owing to the atrophy of long and medium length fibres proceeding from lower levels, and although there is no posterior root degeneration above this level, it is not until we reach the seventh cervical segment that the sclerosis in the root zone entirely disappears. Eighth cervical.—Not much degeneration of rootfibres, cornu radicular and Lissauer's zones almost free of Seventh cervical and upwards.—The roots are healthy, and two well-defined tracts of sclerosis are seen, one overlapping the triangle of Goll's column, but a healthy strip intervening. We have seen that the roots of the lowest lumbar and sacral regions were almost devoid of fibres, and I have shown experimentally that nearly all the fibres of this triangle of Goll's column come from the fourth and fifth lumbar and first and second sacral roots, which were, correspondingly, in this case the roots especially atrophied. Above this level, up to the ninth dorsal, the roots contained a large number of healthy fibres; we must, therefore, accord to this narrow, undegenerated Λ -shaped strip an origin from these roots.

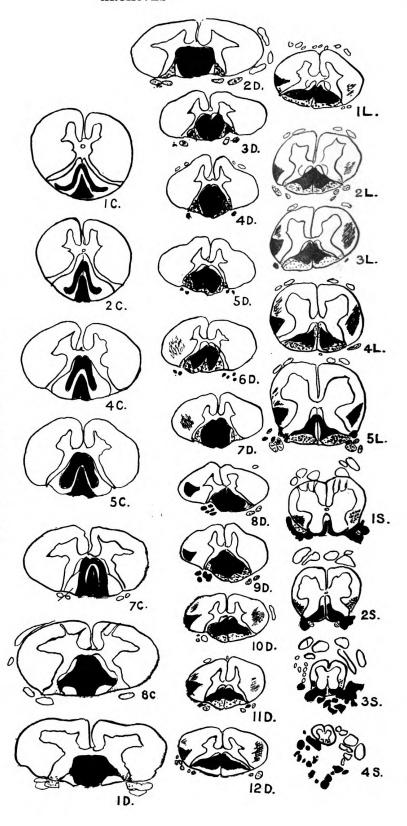
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Fig. 35.
Drawing made with Edinger appa-

with Edinger apparatus. Black part indicates complete or very extensive degenerative sclerosis. Dots indicate partial degenerative sclerosis. It will be observed that the eighth and ninth segments show a marked degenerative atrophy of the roots and posterior column on one side. Possibly this may be associated with the gastric crises.

associated with the gastric crises.

*The degeneration of the crossed pyramidal tracts is not so complete as the above would indicate.



and they convey, in all probability, kinæsthetic impressions from the large muscles connecting the trunk and legs and the lower part of the trunk. At the level of the second cervical we have in front of this a Λ-shaped area of degenerative sclerosis, which corresponds to the outfall of the root-fibres in the upper dorsal and lowest cervical regions; here again it is certain that these fibres belong especially to the segments of the cord conveying kinæsthetic impressions from the small muscles of the hands, viz., eighth cervical and first and second dorsal, for I have shown experimentally that the greater part of the fibres which form this portion of the cerebro-petal kinæsthetic tract come from the eighth cervical and first dorsal segments, which we know innervate the small muscles of the hand.

In front of this at the level of the second cervical, the healthy fibres of the roots entering the cord in the cervical region, and on their way to the postero-external nucleus (Burdach's) have taken up their position in the form of a Λ , the limbs of which at their base are continuous with the root zone.

The Λ -shaped strips of fibres coming from fibres of the posterior roots are segmental, each root sending a certain number of fibres which take up a position lapping over the last, and, as we have seen, the number of fibres which each root provides is distinctly proportional to the complexity and variety of movement of the structures innervated, thus the great bulk of these fibres, viz., the fourth and fifth lumbar and the first and second sacral which innervate the muscles of the feet, the eighth cervical and first and second dorsal, which innervate the small muscles of the hand come from the mobile apices of the limbs. Sherrington has shown that from above downwards in the cerebral cortex there is spinal segmentation of the efferent path to the muscles in the motor area of the ascending frontal. Here in the posterior column we have a spinal segmenation of the afferent kinæsthetic path, and just as the greater part of the upper two-thirds of the motor area is concerned with the complex movements of the hand and foot, so the greater part of the kinæsthetic path to the cerebral cortex is concerned with conveying impressions from the hand and foot.

Association of morbid anatomical conditions with symptoms.—
(1) The advanced and unusually pronounced degeneration of the lowest sacral roots—early impotence. (2) The presence of fibres in the posterior roots of the third and fourth lumbar segments in addition to the crossed pyramidal degeneration on both sides, but more marked on one side—the knee-jerks present on both sides,

but greater on the right than the left. (3) The obvious atrophy of the posterior horn in the seventh and eighth segments on one side with shrinking of the cord (as in Case 31)—the existence of gastric crises. (4) Atrophy of the tangential, supraradial fibres and molecular layer, small and medium sized pyramids, especially of the frontal and fronto-central regions—progressive dementia. (5) Slight vascular changes, little glia cell proliferation—no pronounced maniacal symptoms or delusions.

Case 49.—Tabic amyotrophy. Tabes affecting especially the arms followed by muscular wasting of small muscles of hands. Seven years' duration, commenced with optic atrophy and terminated with mental symptoms and convulsions. Postmortem examination.—Wasting of hemispheres, especially the right, granular ventricles, other naked eye and microscopic characteristics of general paralysis. The cord exhibited the usual appearances of advanced tabes, but also atrophy of anterior horn cells in lower cervical and upper dorsal regions, also atrophy of cells of Clarke's column with degeneration of ventral and dorsal cerebellar tracts.

A. J., aged 42, single. Admitted to Marylebone Infirmary, May 1, 1894. For the last thirteen years, parcel-post sorter, previously a soldier. History of a buboe ten years previously. Fifteen months ago eyesight began to fail, drooping of the left eyelid, double vision, and things appeared smaller than natural. He also suffered with attacks of giddiness, lightning pains, and later weakness in the legs which prevented him walking.

The following notes were taken on admission.—Left eye, external strabismus, pupil half the size of that of right, can only just appreciate light with this eye. Right-eye movements to right made with difficulty. He cannot distinguish objects on the right side of him. Pupil much dilated. Nystagmus in both eyes in upward and downward direction. Both pupils are said to react to light and accommodation. The arms.—No apparent wasting. muscular power good, great loss of coordination in both arms, deep reflexes cannot be obtained; complains of numbness in hands, but sensibility to touch seems normal, sensibility to heat and cold also normal. Legs.—Muscles feel flabby, patient says his legs are much thinner than they were. Knee-jerks absent; sensation normal. On trying to walk patient staggers helplessly. Taste.— Can distinguish between hot and cold, salt and sweet, but is very slow in distinguishing flavours. Bladder normal, no incontinence. Speech natural. September 6, 1894. Seen by Dr. Beevor who found muscular sense very much impaired. Sensation to touch indefinite. No loss of tactile sensation in legs. Muscular sense much impaired. Wasting and loss of power in thumb muscles. November 19, 1895. Small muscles of the left hand give no reaction to faradic current. Small muscles of the right hand thenar, hypothenar and interossei require a stronger current than normal to give the faradic reaction. Sensation to touch is blunted on chest and arms, no loss of sensation to heat and cold. On moving the fingers the patient can tell which fingers are moved, but is unable to state what the movement is. Incomplete loss of muscular sense. Eyes.—Marked nasal hemianopsy still present. Right pupil does not react to light or accommodation, the left reacts to accommodation, but not to light. Loss of sensation to touch in both legs, but no analgesia over legs.

1899.—Examined by Dr. Beevor. Partial anæsthesia found in legs, localisation very poor. Very little tremor in the facial muscles. Patient now has power in the biceps and deltoid muscles of the left arm, and can flex and extend fingers. He has periodic attacks of exaltation.

May, 1900.—Analgesia in both upper extremities, anæsthesia on both sides up to clavicle, including arm.

On November 6, 1900, he was first seen by me, and I made the following notes. He is now semi-delirious, and not in a fit state to test sensation. On Sunday last, November 4, he had a fit, cried out, and lost consciousness for two minutes. A good deal of twitching, convulsive in character, took place on the left side, arm, leg, and face, and this lasted for twenty-four hours. He has not lost consciousness since then. Previous to this attack patient was noisy and sullen, but had no delusions. Since the attack he has seen people coming into the room and called out to them saying He has not refused food since fit, or had they were robbers. Since Sunday night he has suffered delusions about same. with vomiting and reaching and also hæmatemesis. Patient has no personal illusions. Nearly blind, right pupil 5 mm., left 4.5 mm. Inactive to light. Slight ptosis, more marked on right side, and partial immobility of right globe. He cannot be made to look when testing vision, being nearly blind in left eye, seeing best with right eye. Notes state that there is optic atrophy and hemiopia. Appetite has been ravenous. There is a little apparent loss of expression on the right side of face. Tongue very tremulous, characteristic of general paralysis, but no tremor of lips, or any speech affection. His lower extremities are very wasted, especially the dorsal flexor group of muscles of the front of the legs, both

the peroneal group, as well as the tibialis anticus and long extensors of the toes; there is talipes equino-varus in consequence, and the toes are plantar flexed; he does move legs, according to the nurse, but only in an incoordinate manner. There is marked wasting of the interrossei and muscles of thenar and hypothenar eminences, especially of the left hand. He moves right hand but not fingers much more than the left, but then only in a most incoordinate manner. He smells ether but not peppermint. He was not in a fit mental state to test sensibility, but apparently he felt pricking with a needle on the legs, as he swore violently.

The patient died January, 1901, and by the kindness of Dr. Lunn the brain and spinal cord and many of the peripheral nerves were forwarded to me for examination. Unfortunately the cord was somewhat damaged in several regions, so that an absolutely complete examination of this interesting material could not be made.

Brain.—Pia-arachnoid thickening, especially over frontal and central convolutions. Right hemisphere smaller than left, and more atrophied. Marked dilatation of lateral ventricle. Ependyma granular, marked granulation of ependyma of fourth ventricle.

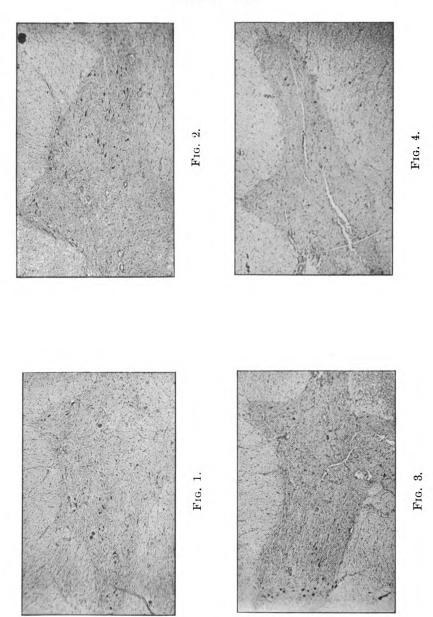
Microscopical examination (Marchi method).—Left Broca, no recent degeneration. Right ascending frontal and parietal and base of second frontal, a number of recent degenerated radial fibres, especially in the two former gyri. Sections of the same convolutions at the level of the base of the first frontal showed not nearly so many degenerated fibres. Left hemisphere, results similar. Orbital lobe and olfactory nerves showed no recent degeneration.

Marchi, Pal, and Wolter's methods.—The same convolutions were examined. First and second frontal.—Tangential and supraradial fibres absent; interradial diminished. Ascending frontal.—Tangential and supraradial diminished. Ascending parietal.—Tangential and supraradial absent; interradial diminished. Broca.—Tangential and supraradial greatly diminished. First temporal.—More tangential and supraradial fibres than in other regions examined. Orbital.—Superficial fibres are diminished. Both optic nerves and tracts show very complete atrophic degeneration as far as geniculate bodies.

Nissl method.—All the above regions of the cortex were examined, and showed marked congestion of vessels, and plasma cells in perivascular lymphatic sheaths. The cells of the deeper layers of the cortex present a fairly normal appear-

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PLATE VI.



Tabes in Asylum and Hospital Practice.

To face p. 197.

ance, in spite of the marked vascular changes. The outline of these cells is well defined, and their apical processes straight. The columns of Meynert are fairly well defined. nearer the surface is approached the more numerous are the atrophied and altered cells, processes being broken off and no longer retaining a pyramidal form, staining imperfectly and showing changes both in the nucleoplasm and cytoplasm. The existence of a cell is often only determinable by the persistent stainable nucleolus. The glia cell proliferation is slight in proportion to the vascular congestion and the cellular decay and destruction. The vascular changes are as marked in the deeper layers as in the superficial; the cell proliferation in the perivascular sheaths is mainly due to lymphocytes. The vascular and cell changes were much less obvious in the calcarine region. It was concluded that the cell change in the superficial layers was for the most part primary and chronic and independent of the vascular, which was acute, and coincident with the attack of acute mania which had supervened a few months prior to death.

Spinal cord.—(Nissl method). Sixth, seventh, eighth cervical, first, second, and fourth and tenth dorsal, first and fifth lumbar and first and second sacral examined. Sixth cervical.-No atrophy of anterior horn cells. Seventh cervical.—Partial atrophy of the anterior and internal groups of anterior cornual cells, the lateral groups being normal, or nearly so. Eighth cervical.—There is marked atrophy and disappearance of the ganglion cells of the anterior horn of the left side, and on the right side the cells are greatly diminished in numbers. Many of them have but few processes, the Nissl-bodies are absent or diminished, their sides convex instead of concave, greatly diminished in size, and in many instances the cytoplasm appears to be filled with yellow pigment granules. First and second dorsal:-There is hardly a ganglion cell to be seen on either side in the anterior horns. On the right there are a few cells in the lateral horn, but these are mostly degenerated. Not only is there a disappearance of the anterior horn cells, but also of the more numerous smaller cordonal cells of the gray matter. There is not a great excess of glia cells but large, thin-walled, dilated veins due to the distension of preexisting vessels were observed, but no old or recent hæmorrhages.

In the lumbo-sacral region the anterior horn cells show chronic atrophic degeneration similar to, but less advanced than that in the cervico-dorsal region. There is also atrophy of the cordonal cells of the gray matter at the base of the anterior horn and throughout the posterior horn.

Sections of cervical, dorsal, and lumbo-sacral regions stained by Marchi method exhibited scattered degeneration of recent character in the antero-lateral tracts, especially the crossed pyramidal; also a little in the posterior columns in regions corresponding to the cornu commissural zone, where practically fibres only exist.

Examination of the spinal cord by Weigert and other methods exhibited a marked degenerative atrophy of all the posterior roots and the exogenous fibres of the posterior columns of the spinal cord, without any marked vascular change to account for the same. The membranes were not much thickened. A considerable substitutive overgrowth of glia tissue exists in the posterior columns, so that they are not so much shrunken as is often the Shrinkage of the spinal cord generally to the size of that of a child in the first and second dorsal, fifth lumbar and first sacral regions, atrophy of the root zone in these regions and of the anterior roots was observed. With the exception of a few fibres in the cornu-commissural zone close up to the posterior commissure (vide Plate VII.), the whole of the endogenous system of fibres are destroyed. Probably this may be associated with the destruction of the cordonal cells above noted. marked atrophy of the fibre plexus of the column of Clarke, and an atrophy of the cells at all levels which accounts for the partial atrophic sclerosis of the ventral and dorsal cerebellar tracts, especially the former. There is also at all levels an atrophy of the cells of the posterior horn accounting for the disappearance of all the descending endogenous fibres and a great part of the ascending (vide Plate VII.). There is marked flattening and shrinking of the cord in the cervico-dorsal region; the posterior columns have in this situation, but nowhere else. a concave instead of a convex external border, indicating longstanding atrophy and shrinkage.

A considerable portion of the dorsal spinal cord had been damaged in its removal, and therefore was not of much use for examination, but in the light of Purves Stewart's case of crush of the cord in the lower cervical region, with descending degeneration in the comma tract, continuance of the same into the posterior external triangle, septo-marginal, oval area, and median triangle of Phillipe (all the fibres of which are completely absent in this cord), and of the fact that there is definite evidence of shrinkage of gray matter and disappearance of cordonal cells in the lumbo-sacral and cervico-dorsal regions, the following facts—(1) atrophy of small muscles of hand and foot, (2)

PLATE VII.



Fig. 1.

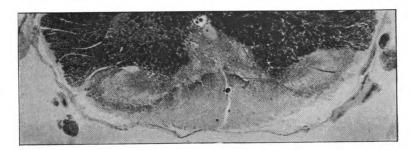
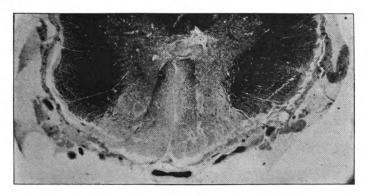


Fig. 2.



Fig. 3.



 $\label{eq:Fig. 4.} \textbf{Fig. 4.}$ Tabes in Asylum and Hospital Practice.

To face p. 198.

ď St. g atrophy of anterior horn cells in cervico-dorsal and lumbosacral regions, (3) atrophy of gray matter and cordonal cells in the region of outflow of nerves to hand and foot, (4) atrophy of endogenous systems of cordonal cells and intercalary neurons show reason for the argument that not until there is atrophy of the intercalary neurons and of the cordonal cells, which give off fibres associating different segments, will the anterior horn cells be deprived entirely of stimulus, and, therefore, undergo regressive atrophy. Destruction of the exogenous systems alone will not suffice, as I have found by cutting a number of posterior roots

In the lumbo-sacral region, where the muscular atrophy was not so advanced, nor the cell atrophy of the anterior horns, the primary nonvascular origin of the process was evident.

I look upon the morbid processes which occurred in this extreme case in the following order: (1) Degeneration of posterior spinal afferent neurons. (2) Degeneration of their association (3) Degeneration of intercalary neurons, resulting in cutting off completely the stimulus from anterior horn cells, for Schäfer has shown experimentally that Von Monakow was correct in his assumption that the crossed pyramidal fibres probably do not directly arborize with the anterior horn cells. (4) Regressive atrophy of the anterior horn cells now deprived of all stimulus, and as a result of this, degeneration of the motor fibres and muscular wasting. Slight degeneration was found also in the pyramids of the medulla, and the crossed and direct pyramidal tracts in the spinal cord. Dr. Purves Stewart has advanced as an argument against the neurone theory the fact that in his case of crush of the cervical cord he has found degeneration in the internal arciform fibres, and, therefore, the degeneration has not been confined to one neuronic system. This to my mind is full of fallacy, for such a severe lesion as a crush of the cord might well give rise to signs of Marchi degeneration (far removed from the seat of the lesion) from vascular disturbances and other causes. I have had considerable experience in examining the medulla after section of the posterior roots, and I have never observed, even after cutting all the posterior roots of one side supplying the upper limb with sensation, any degeneration in the internal arciform fibres and fillet. I have examined now the cords of twenty-eight cases of tabes and tabo-paralysis, and even in such extreme posterior column degeneration as this case presents, I have never seen any atrophy of the internal arciform fibres, although there is complete fibre plexus atrophy of Goll and Burdach's nuclei. In refutation of this statement of Purves Stewart I call the attention of my readers to Plate VII., fig. 1, showing the condition of the internal arciform fibres as they leave the posterior column nuclei to decussate in the mid line to form the fillet.

Another fact worthy of note in this case is the existence of some fine fibres in the roots of the cauda equina, and also the entering rootlets of the lumbo-sacral spinal segments. These fibres belong to the external group of fibres, and break up immediately into fine collaterals around the neurons of the substantia gelatinosa. According to Bechterew they subserve cutaneous sensibility. When the sections of the spinal cord were stained by Bolton's iron alum method these fibres were seen fairly numerous in some sections, whereas the inner group of coarse fibres are entirely absent in the roots and in the cornu radicular zone. We can associate this anatomical finding with the fact that the patient was apparently aware of rough pricking of his legs when I tested him, although he was completely helpless and almost blind.

The ulnar nerves hardly contained any fibres, the nerve was shrunken, and the fasciculi consisted mainly of thickened epi-peri and endoneurion. The median was only slightly affected, and the musculo-spiral not at all. The sciatic nerve was, like the other nerves, much smaller than natural; microscopically all the bundles showed a marked outfall of fibres, but the atrophy was not nearly so marked as in the case of the ulnar nerve.

This quite agrees with the clinical history of the affection commencing in the arms, and of the paralysis affecting the small muscles of the hands.

- Case 50.—Tabo-paralysis, ataxy of some standing. Attack of mania, grandiose delusions and progressive dementia, death six months later.
- J. H., occupation bedstead packer, using a treadle all day long, admitted to Cane Hill, September 20, 1901, aged 39, from Shoreditch Infirmary. No family history of insanity or nervous disease.

Physical condition.—Irides blue, pupils in faint light, right $3\frac{1}{2}$, left $2\frac{2}{3}$, accommodate to $2\frac{1}{2}$ and 2 mm., strain accommodation, equal, 2 mm. No reaction to light, both somewhat irregular, especially the right. Extremely marked tongue and jaw jerk, patient cannot satisfactorily protrude his tongue owing to the jerk.

Speech very slow and drawling, with considerable slurring, and at times such marked hesitation that it is impossible to make out what he wishes to say. Marked tremor of lips. Left upper abdominal reflex absent, the others normal. Scar of a stab to the left of the xyphoid cartilage and a hole through into the abdomen which readily admits the finger. Patient says that it was done by his wife with a butcher's knife. Sensation is delayed (both touch and pain) over the abdomen (which is retracted) and chest to about two inches above the nipples, and on the front of the chest up to this level there seems to be a condition almost of analgesia. The results are, however, unreliable owing to the mental condition of the patient. The heart is normal. There are signs of old consolidation of the apex of the left lung. several papery scars on the legs, one of which above and inside the left knee is markedly serpiginous in outline. The knee-jerks are absent, patient feels touch and pain, but has no true plantar reflex. If either touched or pricked on the soles of his feet, he, after a considerable latent interval, rapidly withdraws the leg, wriggles in bed, and complains bitterly of being hurt. Hypotonus to 15° beyond a right angle, arm reflexes absent, right grasp fair, left grasp very strong. Patient cannot support himself on his legs without help. On trying to walk, there are extremely marked ataxic movements of the legs, with stamping of the heels; Romberg sign is well marked. There is a marked scar (patient says of a "chancre") on the left side of the corona on the under surface of the foreskin. Patient volunteers the information that he has had "syphilis."

General condition.—Patient is a very feeble and emaciated man, who is unable to walk or attend to his own wants. He is at present somewhat drowsy owing to his having had a powder administered yesterday evening. This was given owing to his extreme restlessness, lest he should be injured by throwing himself about. During examination patient either replies drowsily to questions or is restless and groans. He complains of pains in his "body, and legs, and all over." No more definite information can be obtained. He looks very ill, and his face is drawn and pinched, but otherwise expressionless.

Mental state.—Patient is confused, very self-satisfied, his statements appear to be altogether unreliable; he occasionally replies to questions, does as he is told, or notices what goes on around him. He says he is married and that his age is 29. He has "a lovely wife and a beautiful daughter, he has been married sixteen years, he has nineteen daughters, he can work the typewriter and is a

printer, he was a sailor and in the Navy." When left to himself he rambles on about going to Australia, to diamond mines and rambling about the coast.

The discs are normal. They are both very pale and suggest moderate atrophy at first sight. Patient can, however, read easily with either eye at about the normal distance, and, consequently, the pallor is normal.

October 10.—The patient's mind is somewhat clearer, and he gave me the following account of himself. He had, in 1884, a sore followed by secondary symptoms for which he was treated some months with mercury pills. He was aged 20 at the time. A few years later he became acquainted with a woman who had left her husband, and they had lived together as man and wife up till six months ago, when she deserted him, and to this he attributed his mental affection. The history he gave, however, suggested that she had been compelled to leave him on account of his habits and infirmity. His illness began three and a half years ago with pains in the legs, difficulty with the bladder and bowels, followed by ataxy and ocular paralysis. He went to King's College Hospital and was admitted under Dr. Ferrier. Soon after this he seems to have had an apoplectiform seizure and was taken up by the police. He has had loss of sexual power for three years; this was preceded by satyriasis. The woman he lived with bore him no children.

Physical condition.—Knee and triceps jerks absent, plantar and cremasteric reflexes also absent. Joint sensation in toes lost, not however in ankle. Joint sensation in fingers lost, ataxic gait, inability to touch nose with eyes shut, hypotonus to a right angle. No anæsthesia of the trunk or limbs detected and no analgesia. This is fairly reliable. He has very marked tremor of the lips and tongue, and the speech is very slurred. The smell is defective, as he is unable to recognise the strong odours of assafætida, cloves, or peppermint. His taste is good, recognises quinine, sugar, and acids. Pupils remain the same as when last examined. He is able to walk, and he volunteers the remark that he was much worse in this respect at one time.

Mental condition.—His knowledge of time and place and memory are fairly good, but he has exalted and grandiose ideas about obtaining watches and jewels, and making large sums of money by pawning them. The attendant states that he is better and has control over his sphincters.

March 1.—Death—Autopsy refused.

Case 51.—Ataxy of some years duration in a man aged 39. Onset of cerebral affection manifested by epileptiform seizures, mania, with grandiose delusions. Death eighteen months after onset of mental symptoms. Marked cerebral lesions characteristic of general paralysis, and marked spinal lesion characteristic of tabes dorsalis.

R. S., aged 39, was admitted to Cane Hill suffering with mania and grandiose delusions. The history was that he had suffered for eighteen months from locomotor ataxy, for which he had been a patient at the Croydon Hospital. The supposed cause of his mental affliction was worry and family troubles occasioned by his loss of occupation as a gardener. He had been married eleven years, and had a family of five children. No history of syphilis was obtainable, and there were no signs on the body.

Physical condition.—Nutrition poor, muscles wasted; he has marked locomotor ataxy. The pupils small, equal, inactive to light, react to accommodation. Knee-jerks absent; gait, walks with a wide base, and is somewhat unsteady. Speech markedly tremulous.

Mental state.—Conversation rambling, irrational, and incoherent. Says his brothers are coming up to the Croydon Flower Show, that they will stay three months; that he has four elephants and fifteen horses.

After two or three months in the asylum his ataxy considerably improved. From time to time he had convulsive seizures, from which he recovered, but his mental condition became progressively worse, although sometimes after the fits had passed over, he would apparently be somewhat brighter. He died of exhaustion of general paralysis eighteen months after admission. (Abstract of notes by Dr. Donaldson.)

Summary of post-mortem notes.—Membranes thickened, opalescent, and adherent to the brain cortex; excess of cerebrospinal fluid, all the ventricles somewhat dilated and markedly granular. Left hemisphere weighed 20 grammes less than the right.

Summary of results of microscopical examination: Brain.—Portions of the prefrontal, Broca's, and central convolutions examined by Nissl and Pal methods showed the characteristic changes of a fairly advanced case of general paralysis, viz., vascular engorgement, thickening of membranes, proliferation of glia cells, dilatation of perivascular lymphatics, with cellular proliferation. Disarrangement of Meynert's columns owing to

acute and chronic destructive changes in the cortical cells, especially of the molecular layer and the small and medium sized pyramids. Atrophy and partial disappearance of the tangential and supraradial fibres, which is most marked in the prefrontal and Broca's convolutions.

Spinal cord.—All regions examined, and showed a naked eye disappearance (with glia substitution) of the intramedullary projections of the root fibres in the lower cervical, dorsal, and lumbo-sacral regions. The endogenous systems of fibres were in this case but little affected. The cornu commissural tract possessed the normal wealth of fibres; there may have been some sclerosis in the comma tracts in the mid-dorsal region, but there was an abundance of fibres in the posterior internal zone, and these could be traced to the lower dorsal region as a strip of fibres amid the sclerosed tissue extending along the periphery of the cord, and at a lower level massing into a small triangle, which, again, at a still lower level, could be followed as the septo-marginal ending in the oval area in the lower lumbar region, and finally continuous with the median sacral triangle.

GROUP 4.—Tabo-paralysis with Marked Speech Affection.

Case 52.—Tabo-paralysis, five years' duration from onset of symptoms, history of hereditary insanity in mother and brother. All the family in the publican line and given to drink. The disease commenced with fits, speech affection, alternate excitement and depression, grandiose and sexual delusions and perversions. Considerable ataxy without anæsthesia, or loss of joint sensation. Superficial and deep reflexes exaggerated. Death from dysentery. Typical general paralytic brain, direct and crossed pyramidal degeneration of spinal cord and typical posterior column degeneration of ataxy. No degeneration of posterior roots or Lissauer's tract of fine fibres; only coarse fibres of entry going to cornu radicular zone. Cord very small.

B. C. A., aged 50. Admitted to Colney Hatch, May 29, 1900. Occupation for fifteen years barman and cellarman, then barber for six years, and finally for the last seven years willing to take any odd job such as painting and decorating. From the account he gives me he evidently lived a very racketty life, drank hard and indulged in marked sexual excess. He denies venereal infection, but there is a scar on the right groin, enlarged inguinal glands, and several papery scars on the legs. He says he has three children, the first of whom was born five years after marriage; two twins had

previously died. It was ascertained that his brother Walter had been in the asylum fifteen years, suffering with delusions of persecution, attempted suicide—cause drink and heredity. Mother died in asylum forty years ago, went out of her mind on account of worry brought on by her husband's gambling, drinking, and immorality. For two months prior to admission to the asylum, he had been having fits. This agrees with the statement of his wife in the Case Book. Prior to admission the wife states he was at times violent, at other times depressed. She and her children were afraid of him when he was violent. She said that he had similar fits some years before admission; he had recently become intemperate and given way to gambling. She had noticed an alteration in his speech two years before admission.

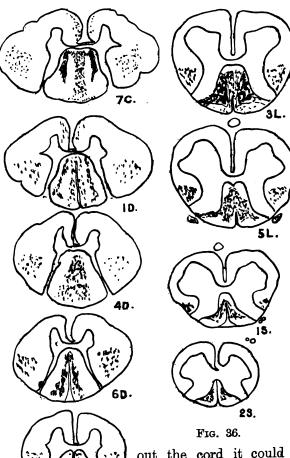
Physical condition.—He has an ataxic walk, heels down first, wide base and considerable incoordination. He has no cord-like constriction, he has no difficulty with his water or bowels. Kneejerks brisk on both sides, muscles well-developed and strength good. There is marked hypotonus of the hamstring muscles both sides and incoordination in the legs, thus he could not place right heel on his left foot or knee, with his eyes shut. No loss of sense of position of joints, and no anæsthesia of the skin could be detected, nor was there any delay in response. Superficial reflexes all markedly increased. Romberg's symptom very slight. Speech very slurred and indistinct. According to the attendant it has become progressively worse. Tongue tremulous and very jerky on protrusion, marked tremor of the lips. Pupils pinpoint, right Inactive to light, react to accommo-2 mm., left a shade less. dation. Roughly tested colour vision normal, no limitation of the visual field.

Mental condition.—He principally exhibits exaltation, delusions, and mild progressive dementia. Expression is rather vacant, but is easily excited to mirth especially when relating his love affairs and virility (sexual delusions and perversions). Orientation time and place fairly good. His memory he says was fairly good. He knew correctly that his wife came to see him last Sunday with his eldest son. He seems to give a rational account of his two sons' employment. He gives correct answers when asked to multiply three by four and six by seven; still answers correctly when the figures are reversed. He remembers songs and words well. Mentally he is not much demented considering the very marked speech affection. He has had no fits since he has been in, there is more difficulty in articulation than anything else. He reiterates that too many women is the cause of his illness. He

thinks that if he puts camomile poultices over himself, he would be quite well.

Death on January 28 of acute dysentery.

The brain showed very marked wasting of fronto-central regions, thickening of all the membranes and atrophy of the convolutions everywhere to some degree, but especially in the frontal



and central regions. Cortex diminished, striation very indistinct. Ventricles dilated, ependyma granular. Naked eye appearances typical of general paralysis. There was a naked eye. change in the posterior and to a less degree in the lateral columns of the spinal cord which could be fairly accurately localised after hardening in Müller's fluid. The degenerative atrophy occupied the root zone; through-

out the cord it could be seen distinctly entering Clarke's column, and in the upper dorsal and cervical regions there was obvious degeneration of Goll's column. Further particulars are given in the complete microscopic examination.

Spinal cord.—The diagram indicates the degeneration which could be seen after a fortnight's hardening in Muller's fluid. It does not represent the actual degenera-

tion which was found by Marchi method, which I will now briefly describe.

Lowest cervical and upper dorsal.—Recent degeneration in crossed and direct pyramidal tracts, degeneration in root zone, some slight degeneration in comma tract.

Mid dorsal.—Very marked degeneration in root zone, in cornu radicular zone, both crossed pyramidal tracts and comma tracts. The same applies to the lower dorsal. At the base of Clarke's column are seen a number of fine degenerated fibres (collaterals), proceeding from situation of crossed pyramidal tract.

Lumbo-sacral.—Marked degeneration in cornu radicular zone, root zone, septo-marginal and oval area, very numerous fine black particles in the pyramidal tracts of both sides, and a few, but not nearly so many coarse fibres as in the sections above described. In the attached roots of not one of these segments examined (and a large number of sections were looked through) could I observe any degenerated fibres in the posterior roots by the Marchi method.

Conclusions.—It appeared, therefore, in this case at any rate, that the degeneration commenced in the intramedullary portions of the neuron. Many sections showed an attachment of the nerve roots entering the cord (vide photomicrograph, fig. 41, p. 274). No degeneration extramedullary, but immediately after piercing the membranes (and therefore losing their primitive sheath), the fibres are completely degenerated.

This acute degenerative process is very interesting as showing either support for Redlich and Obersteiner's Theory of Meningeal constriction, or, as I believe, an acute primary degenerative process commencing in the portion of the neuron where the primitive sheath is absent. The membranes are not thickened over the posterior columns nor at the root entry. Another point of interest is that although there was a considerable outfall of exogenous fibres in the lumbar enlargement as shown by the Weigert method of staining, yet a considerable number of fibres can be seen entering the root zone. Of course, a great number of these may be degenerated as shown by the Marchi method.

Such an amount of degeneration would, I think, under ordinary circumstances, have been sufficient to abolish the knee-jerks, but there was a crossed pyramidal degeneration both sides. There was very considerable recent degeneration of descending and ascending endogenous fibres, and this may partially account for the pronounced ataxy.

Case 53.—Tabo-paralysis, first symptom inability to use his tools, then has left-sided fits, affection of memory and speech, development of ataxia, no cutaneous sensory or visceral symptoms. The degeneration apparently has affected the motor afferent and efferent systems, and the kinæsthetic centres of verbal and written speech. No delusions.

J. F., aged 36, cabinet-maker, transferred from St. Pancras Workhouse Infirmary to Hanwell, December, 1901. In April, 1899, he was an outpatient at Queen Square Hospital under Dr. Beevor, who has kindly furnished me with the following notes:—Syphilis ten years before. History of two fits left-sided. Pupils R. > L. reacted to accommodation, not to light. Tremor in tongue and lips. Speech suggested general paralysis. Mentation slow, fixation bad. Romberg's symptom, ataxic gait. No lightning pains, no anæsthesia, no analgesia. Sphincters not affected. Memory very bad, nil ophthalmoscopic. Diagnosis general paralysis or tabes, with an inclination to the former.

This account closely corresponded with the account the patient gave me concerning the fits and his subjective symptoms, so that his answers may be considered reliable as to his present condition. Married seven years, no children and no miscarriages. There is a scar in the groin, cervical and inguinal glands enlarged. He states that he was treated with strychnine by Dr. Beevor, and that he had had two left-sided hemiplegic attacks affecting his speech and memory. He fell down suddenly in the Euston Road, losing his senses, and when he came to, his speech was affected and his memory bad. He states that for some time previous to the fits he was unable to do his work, because he could not use his tools.

Physical condition.—His gait is markedly ataxic. Romberg's symptom marked. He has no pains. There is incoordination in the hands and some loss of sense of position. He suffered with bladder trouble while in the workhouse, necessitating use of catheter. He has now no control over the sphincters. Never had double vision. Pupils 4 mm., irregular, A. R. Knee-jerks absent both sides, triceps and wrist tap obtained on both sides. Some incoordination in the hands. Face congested, flushed, greasy skin, emotionless, blank expression. Tongue and lips tremulous, speech hesitant and syllabic. Sensory. No analgesia or anæsthesia discovered anywhere. Superficial reflexes present.

Mental state.—Slow reaction. Thinks he is in St. Pancras Workhouse, he knows the day of the month, but there is a

moderate amount of dementia. He has no delusions, hallucinations, or illusions.

April 9, 1902.—Physical condition very much the same, except that he is more helpless. He lies with legs and thighs semi-flexed, but feet plantar flexed and inverted owing to weakness of dorsal flexors of feet and peronei. The feet are blue and cold, and the plantar reflexes are now absent. Epigastrics are present. It is impossible, owing to his mental state, to test in a reliable manner his cutaneous sensibility; but there is undoubtedly hypalgesia all over the body, and analgesia of the lower part of trunk and legs. There is paresis of left external rectus and double vision. Pupils 4 mm., equal A. R. He cannot stand without support, and if he closes his eyes he sways to and fro. His speech is very syllabic and slurred. When asked to write he was unable; he tried to hold the pencil between the middle and ring fingers, closing his fist, but he could make no movements, and dropped it. He cannot walk without assistance; the gait, when supported by an attendant, was noted. He walks with rather a wide base, brings his heels down first, throws out and circumducts advancing leg so as to clear the ground with the foot which is plantar flexed and inverted; he does not flex the knee at the commencement of the step, but keeps it extended, and the ground is cleared by abduction and circumduction of the leg. He uses his right leg more than his left for progression.

Case 54.—Tabic paralysis, Babinski's sign, successive right-sided fits, absent knee-jerks, aphasia, hemiparesis and hemianæsthesia of a temporary character at first, but followed later by permanent defect, death in a fit, great wasting of left hemisphere, no coarse lesion, marked pyramidal degeneration, direct and crossed in the cord, with old posterior column sclerosis. Large amount of cholin in the blood.

D. G. W., aged 45, journalist. Was admitted into Charing Cross Hospital, February 20, 1902, having fallen down in a fit. The next day when I saw him he was conscious, but unable to speak or write, nor did he seem to understand what was said to him. When talking to the students on his case, he behaved like a man who was listening to a foreign language, and who understood every now and then a word that was said. The pupils are unequal and inactive to light, active to accommodation. The knee-jerks are absent on both sides, and there are typical syphilitic scars on the legs. The plantar reflex on the right side

gives a well marked extensor response; there is some rigidity in both the right arm and leg, and hemiparesis. Slight paresis in the lower part of the face on the right side; lips tremulous, tongue tremulous, protruded very slightly to the right. Diagnosis tabic-paralysis. A few days later I ascertained from a relative that this patient had been treated for locomotor ataxy. He also informed me that the patient had for some time acted strangely. There was no history of insanity in the family. The patient in a few days partially recovered his speech. He left the hospital, had another fit, and was taken into King's College Hospital; there he became troublesome, showed signs of dementia, and was certified and transferred to Claybury Private Asylum, March 11, 1902, where I saw him again. He did not recognise me, although he was able to speak now, and to tell me that he was a journalist connected with the Globe newspaper. I made the following notes: There is no doubt that he is suffering from paralytic dementia with tabetic symptoms. His speech is hesitating, stumbling, and words are occasionally clipped and slurred; his comprehension is poor, and he has marked loss of memory, in consequence of which he is incoherent and rambling in his conversation. His orientation is defective. Pupils unequal, irregular, left the larger, both react very sluggishly to light. March 22, the patient gradually became hemiparetic on the right side; the arm showed entire loss of muscular sense and tactile sensibility, though general sensibility from the coarse point of view was present; he was unable to perform any voluntary movement with it, but simply made spasmodic attempts to do what was desired; he could not place a pencil in the hand owing to the extreme anæsthesia of the fingers. The grasp, however, in the right hand was very good on bilateral squeezing, although delayed, and he was also able to perform bilateral movements, such as raising both arms above the head, and putting them in various positions, especially if the action was first performed once or twice by the left hand. He occasionally got a word out, but very rarely, most of his replies being of the nature of gibberish. He, however, understood perfectly all that was said to him, and at times, when not endeavouring to use a particular phrase or word, got out a short reply quite distinctly. Right lower face paretic. These facts, together with subsidiary details not referred to, point almost conclusively to a temporary cortical vascular disorder, involving in order of severity the face. arm, and leg areas.

At the commencement of April he began to get wet occasionally, and more demented. Since the last fit he has not recovered the

power in his right arm. The mental condition became worse, and on June 13 he had another fit, became unconscious, and died suddenly in a convulsion, 3.25 a.m.

Abstract of post-mortem notes.—Cause of death, exhaustion, general paralysis. Cerebral hemispheres, right 542 grammes, left 480 grammes. Ventricles.—Dilated and granular, especially the tourth. Pia-arachnoid.—Thickened and somewhat opaque, especially over frontal and central regions of lest hemisphere, which is markedly atrophied. Spinal cord.—After hardening in Müller for two days, exhibited characteristic gray degeneration of posterior columns, degeneration of both crossed pyramidal tracts and the direct tract of the left side, very obvious to the naked eye. The blood taken from this case yielded, comparatively speaking, a large amount of choline, thirty minims of blood being sufficient to show large numbers of octahedral crystals of good size of the double salt of choline and platinum. All the vital organs were, to the naked eye, perfectly healthy; there was no obvious organic disease; the body was well nourished, and no morbid appearances presented themselves, except in the above-mentioned cerebral condition.

We might, therefore, presume that the patient may have really died from toxemia; for although choline is a comparatively feeble poison, yet with other bodies of the cholin group existing in the blood and cerebro-spinal fluid in such large amount as the above test indicates, might suffice to produce toxic effects.

Naked eye examination of brain after hardening in Formol-Müller and stripping the membranes.—On both sides there is thickening of the membranes, the left hemisphere is obviously smaller than the right, the convolutional patterns of the two hemispheres are complex, and pretty closely resemble one another in the form, number and distribution of the sulci and convolutions. Placed with the mesial surfaces in apposition, the top of the fissure of Rolando on the two sides being made to approximate, it is shown that the prefrontal tips also approximate, and there is convolutional symmetry in size, and fairly in form of the halves of the cerebrum; but behind the fissure, all the convolutions of the left hemisphere are markedly atrophied, especially the ascending parietal, the para-central lobule, the angular and supramarginal convolutions, so that the tip of the occipital lobe of the right hemisphere projects quite half an inch further back than the left—this being mainly due to atrophy of the convolutions behind the fissure of Rolando. The temporal lobe of the left hemisphere is smaller than that of the

right, and especially noticeable is the difference in size of the first temporal on the left as compared with the right side. The posterior third of this convolution is very small and atrophied. The atrophic process then has affected, especially in this journalist, the auditory and visual word centres. The appearances of the left half of his brain conforms to the symptoms manifested during life, viz.—sensory aphasia and paraphasia, confused ideation of verbal and written speech, although he could utter articulate sounds. His speech defect was not like that of an ordinary general paralytic. Preliminary microscopical examination of the brain showed characteristic changes of an acute nature, cell and fibre destruction, glia proliferation, plasma cells around the vessels. Medulla and spinal cord.—Abundant degeneration was found by the Marchi method in both pyramids of the medulla, especially the left, and in the left direct and right crossed pyramidal tracts (vide fig. 42). There were also numerous degenerated fibres in the right direct and left crossed pyramidal tracts. By the Weigert method there was naked eye degeneration of the left direct tract in the cervical region, and of the right crossed pyramidal tract, and to a much less degree the left throughout the cord. The crossed pyramidal and prepyramidal tracts on both sides stain indifferently as compared with the rest of the antero-lateral regions of the cord, as if there was some chemical change in the myelin apart from the sclerosis due to overgrowth of glia tissue. The posterior columns show a marked sclerosis corresponding to the disappearance of the intraspinal projections of the posterior roots. There is a nakedeye sclerosis of Goll's column in the cervical region; marked atrophy of the cerebello-petal fibres of the lumbo-sacral roots, and correspondingly of the plexus of fibres around the cells of Clarke's column in the lower dorsal and upper lumbar segments; and marked atrophy of the root zone in the lumbar and sacral regions. The lower lumbar and sacral roots are considerably denuded of fibres, half to one-third. Lissauer's tract of fine fibres is apparently little or not at all affected. There is no atrophy of the endogenous systems of fibres. The septo-marginal and oval area and sacral triangle show no outfall of fibres. The symptoms and signs observed during life can be explained by the morphological changes. The spinal lesions correspond to an early condition of the first stage of ataxy in which the skin sensibility of the soles persists, hence the plantar reflexes were obtainable. On the right side there was marked sclerosis of the crossed pyramidal tract, hence the extensor response in the sole reflex. Although

there was this marked pyramidal degeneration, the knee-jerk did not return, because of the extensive degeneration in the root zone breaking completely the reflex path of spinal muscular tonus.

Case 55.—Tabetic general paralysis, in which noticeable symptoms were first mental, and subsequently spinal. No history of insanity in the family. Analgesia all over the body.

H. E., aged 38, admitted to Hanwell, January 29, 1896, occupation carman, married and children, always been a total abstainer, no family history of insanity, fits, phthisis, or nervous disease. There is a large scar on the penis, admits having had syphilis and having been treated for it. He has enlarged glands in the groins. His illness commenced in 1895. He became irritable, falling into heedless passions, would get up at night and run out of doors, threatening his wife and children with violence. He then began to stagger in his walk, his speech became indistinct, and his memory weak.

History (obtained from wife, June, 1900).—H. E., now aged 42, occupation carman, married at 23, seven children resulted from marriage, five of whom are alive, and two dead, aged 11 months and 14 months respectively. Wife had one miscarriage. Six months before he went to Hanwell patient became very irritable and forgetful, nothing pleased him. He complained also of giving way of his legs, and of pains, which he thought were rheumatic, in his arms and legs. Pains were shooting in character. He complained also of pains in the stomach, with appearance of a lump that disappeared. Wife noticed that he had a difficulty with, and that there was a hesitancy in, his speech. Patient was a very temperate man. There is no history of insanity in the family on either side. Before his illness patient was a good husband and father, a strong man, of a very-easy-going placid disposition, and had nothing to worry about. He used to sleep well. She brought her boy to the hospital to see me, as she feared he might be going like his father; the following notes were made:-

A. E., aged 13 years, the fourth child of the marriage. When he left school he was in the fourth standard. He was discharged from the Farm School for having stabbed two boys; he knew perfectly well what he was doing. Knee-jerks weak, only obtained by reinforcement, pupils equal, react to light and accommodation, no tremor in speech. The boy's mother notices no difference in him, he is good and affectionate. He suffers with headache now at times, affecting the back of the head, but he is never sick. His knowledge of time and place is good, simple judgment also good.

He laughs and talks in his sleep, and does not rest properly, but he never wets the bed. No history of fits. He has lately had a discharge from the ear; glands are a little enlarged.

September 26, 1900.—The following notes were made by me: About a year ago the patient had a congestive attack and remained in a dazed semi-conscious state for some days. He has had none since. He is childish, but has no marked delusions; his memory is poor, and his knowledge of time and place imperfect, but not absolutely lost. The speech is syllabic, hesitant, and slurred, tongue tremulous, and he has a mask-like expression denoting an emotionless state of the brain, but he occasionally bursts out into a childish laugh. He has an ataxic walk, the kneejerks are absent, pupils medium sized, unequal, inactive to light, react to accommodation, complains of no girdle sensation, Romberg symptom well marked, considerable degree of hypotonus of muscles of the legs, the legs being capable of being bent at the hip to a right angle. He nowhere feels the prick of a pin, not even in the meatus urethræ, but responds with some delay to touch all over the body. When you prick him he says that it is a touch.

June 18, 1901.—Some time ago the patient commenced to have fits affecting the right side, followed by loss of use of the right limb, and the speech became even more indistinct and slurred. The hemiplegic condition has somewhat improved, but one can still see continuous involuntary twitchings in the right leg. Lying on his back he can voluntarily raise the leg from the bed, and he can use his arms without any marked incoordination of movement. The muscles are all very much wasted, and their power enfeebled, but the reason why he is unable to stand is mainly due to the ataxy. There is very marked hypotonus in both legs, and the deep reflexes are lost. He has no power over the bladder, and the water dribbles away continuously into the bed. Although the speech is so markedly affected, the dementia is rather childishness than anything else. He takes an interest in his surroundings, and an elementary knowledge of time and place is not wanting. He told me spontaneously that his neighbour had been in the asylum eighteen months, which was correct.

August 20.—A fortnight ago the patient had an attack of vomiting, very severe, which lasted for two days, accompanied with diarrhœa. He has not spoken since then. He is quite helpless, lying in bed on his back, did not recognise me, but he recognised Dr. Spark, and apparently made an attempt to speak. He is very emaciated, has complete loss of control over the sphincters, epigastric reflexes just present left side, absent right,

plantar reflexes present both sides. Pupils, right, 6 mm., left 5 mm.

The patient died September 10, 1901, of dysentery, of which he had suffered several attacks. The whole large intestine was in a state of acute and chronic ulceration. The brain, spinal cord, nerves, and muscles were removed by Dr. Bolton, and, owing to the softness of the central nervous system, the two former were placed directly into formaline, in order that they might be hardened before any descriptive examination was made. After a fortnight in this solution the brain and spinal cord were examined. The hemispheres show but little thickening of the pia-arachnoid generally, and there was not much wasting. Each hemisphere weighed 633 grammes; the cerebellum and pons, with the medulla, 140. There is some thickening of the pia-arachnoid over the mesial surface of both frontal lobes, especially the left. There is also thickening of the membranes over the left hemisphere in the following regions: the lower part of the Rolandic area, the adjacent Broca convolution, and the anterior portion of the first temporal. There is wasting of these structures, as is shown by the fact that the anterior portion of the Sylvian fissure is wider on the left than on the right side. It is covered, moreover, with thickened pia-arachnoid membrane. The bases of the first and second frontal convolutions and the adjacent portion of the ascending frontal are obviously wasted as compared with the right. The intervening sulci are deeper and the covering piaarachnoid thicker and more opaque. The lateral ventricles are apparently not much dilated, but the ependyma is slightly granular, likewise the ependyma of the fourth ventricle. The spinal cord appears smaller than natural, but does not look flattened posteriorly. The posterior roots in the dorsal and lumbo-sacral regions, especially the latter, appear smaller and more gray and translucent than normal. On cutting the cord transversely, obvious naked-eye degeneration is visible in the posterior columns, exhibited by gray-red translucency as compared with the dead white of the antero-lateral columns.

Case 56.—Tabo-paralysis of motor type, which commenced with occasional attacks of transitory loss of speech. History of insanity in family. Grandiose delusions and alteration in manner and disposition. Admission to asylum, on account of acute maniacal symptoms, development of motor paresis and ataxy; subsidence of mental symptoms, very little dementia.

A. A., admitted to Hanwell, May 4, 1901, aged 40. Occupation, for a long time manager of Sanger's Circus. Has travelled

all over the world. Latterly, since he has lost his place, which has worried him a great deal, he has been a string bag maker. He has been married eleven years, no children, no miscarriages, steady and temperate. Father and paternal grandfather were insane.

History of present illness (from wife).—Two years ago he suffered with occasional attacks of transitory loss of speech and a bewildered look. Two or three months ago he became altered in manner and disposition, turned against his wife; and imagining he possessed thousands of pounds, indulged his extravagant ideas by buying useless articles.

Physical condition.—June 28, 1901. Walks with a wide rather ataxic gait, knee-jerks not obtained, some unsteadiness with the eyes shut, expression rather emotionless, tremor of tongue and face muscles, marked slurring and hesitancy in speech, pupils unequal, right 6 mm., left 5 mm., inactive to light, active to accommodation. Well marked syphilitic history, parchment scars on the body. There is a suppurating corn on the right little toe, now healed; marked hypotonus of hamstring muscles, no loss of joint sensation, no analgesia.

Mental condition.—He shows very little mental defect, he is able to give a rational account of himself and his doings in the past. He has no grandiose delusions now, and his knowledge of time and place are only slightly defective. There is no incoherence in his conversation, in fact, his disease appears to have affected especially the motor tracts.

July 4, 1901.—Pupils the same, mental and physical state unchanged. No cutaneous anæsthesia of thorax.

October 4.—Simple-minded, officious, declares that he feels quite happy. He has a perforating ulcer on the right foot, which causes him a lot of trouble at times.

October 30.—Perforating ulcer of right ball of little toe, also corn over ball of great toe. Speech much affected. No loss of joint sensation, no analgesia of feet and legs, no thoracic anæsthesia. Pupils equal, right slightly irregular, no reaction to light, slight reaction to accommodation. No attacks of sickness, no bladder trouble, Romberg symptom slight. Twenty years ago he had syphilis; there is a scar of an old gumma on the right thigh. Deep reflexes of legs lost. Mentally he is only slightly exalted; the facial expression also denotes exaltation of only a slight degree. He is clean in his habits.

June 19, 1902.—Suppurating corn on right little toe. He has no loss of joint sensation and no analgesia.

April 9, 1902.—Physical condition.—He walks with a slightly ataxic gait, the feet apart and bringing the heels down first. Knee-jerks absent both sides even with reinforcement. Lying in bed on his back, weakness of dorsal flexors of both feet noticeable in synergic actions of flexion of hip joints. Hypotonus of hamstrings equal on the two sides. Slight loss of sense of position in feet. None in hands. No loss of joint sensibility detected in feet or hands. No cutaneous anæsthesia or analgesia. No shooting pains in legs, no girdle sensation, no bladder trouble. All superficial reflexes present, also deep reflexes in arms. Sways a little with eyes shut, but can stand, though with some difficulty, on one foot. Speech is markedly affected, tongue and face muscles tremulous. Vaso-motor-paresis of vessels of face. He has lately had a number of congestive and epileptiform seizures.

Mental condition.—He is not the subject of delusions or hallucinations and he is only slightly demented as he can converse on most subjects rationally and his memory is good. He told me that when he reads it is not necessary for him to read the words silently; he can do it by visual impression only.

Case 57.—Tabes following injury, modified gastric crises, causing delusions that his stomach had been swollen to enormous size. Death from tabo-paralysis.

L. H., aged 35. Admitted February 16, 1902, died May 31, 1902. Dock labourer, married.

Dr. Jones' note (February 21st, 1901, Claybury Asylum).— He is suffering from tabetic paralytic dementia. Mental reaction slow, and he has impaired memory, loss of knowledge as to time and place. He is somewhat depressed, and cannot realise where he is. He does not think there is anything the matter. He tells me he has six children, but he shows no concern to get to them and look after them. There is marked dementia. He is in fair nutrition, health impaired. Right pupil reacts slightly to light, the left less; both are irregular, the right rather smaller. Knee-jerks absent. Common sensation in the legs retarded, cannot tell quickly when pin-pricked. Cannot stand blindfolded, and there is a tabetic gait.

January 9, 1902.—Mental reaction slow, is entirely lost to his surroundings, expresses delusions freely, says he is being worked on by electricity. He is fairly well nourished, has symptoms of tabes dorsalis. Knee-jerks absent, pupils react sluggishly, marked incoordination. Very fine facial tremors. Romberg's symptom.

History (from wife).—Dock labourer. Married twelve years. Four children alive, two dead, the first and last, eldest living 11 years, youngest 3½ years. Sister suffers with epilepsy. Seven years ago he had an accident, a bag of sugar weighing 2½ cwt. fell across the back of his neck. He was in London Hospital two days. Unable to work for three months, and received £15 compensation from his employers. Three years after the accident he commenced to have rheumatic pains, and pains in the stomach which were thought to be dyspepsia at the London Hospital. Complained of his head, and was very irritable. Always a man of moods ever since she knew him. He has experienced difficulty with his water and bowels, being very costive. He would go without food for days because of pains, but was not sick. He always said he felt as if something was drawing him in. Complained of crawling sensations. He had a kind of fit eighteen months ago when he was taken into sick asylum, then he tried to get out of the window. Transferred to Poplar, and then here. He was a good husband and a good father. Frequently visited by wife, who noticed that his mind became weaker each time. He had no fits that she knew of. Always complained of the pains and the dyspepsia, even recently when she visited him. Very much wasted. Syphilis doubtful. (F. W. M.)

Medical certificate.—He is under the delusion that his stomach has been swollen to an enormous size, also that people have conspired to put him away. At times he is quite lost in his mind.

Communicated by wife.—Strange in his manner, rambles in his statements. He was under the delusion that his body became swollen and of an enormous size.

Post-mortem notes. -- State of nutrition and muscular system emaciated. Syphilis, no visible scar on penis; history of one in private notes made by Dr. Bolton. Skull somewhat dense. Average frontal thickness 6 mm., parietal thickness 31 mm., occipital thickness 7 mm. • Pupils equal. Subdural space.— Marked excess of fluid. Pia.—A little fronto-parietal milkiness, marked prefrontal adhesions and tearing of cortex on separating prefrontal lobes. Encephalon.—1,340 grammes, exceedingly œdematous. Weight of right hemisphere, 565 grammes; weight of left hemisphere, 550 grammes. General wasting of convolutions, obscured by cedema. Ventricles immensely dilated and granular. Cerebellum weight, 170 grammes, ædematous. Fourth ventricle. — Markedly granular, especially calamus. nerves.—Œdematous. Spinal cord as small as that of a child of

two years in the dorsal and lumbo-sacral regions. Obvious gray atrophy of posterior column, but no flattening of the posterior surface, soft meninges opaque and thickened. Thorax.—Bronchi a little congested. Bronchial glands cedematous. Right lung, weight 535 grammes, congested and broncho-pneumonic. Left lung, 415 grammes, more congested and broncho-pneumonic than right. Heart-A little wasted, weight 205 grammes. Aorta and great vessels.—A small amount of early atheroma. Abdomen.—Liver weight, 1,150 grammes, much congested, density increased. Spleen, weight 78 grammes, density much increased. Right kidney, weight 95 grammes, cortex 4-5 mm., density increased; strips fairly readily. Left kidney, ditto. Abdominal aorta.—Slight early atheroma. Stomach.—Patchy congestion and chronic catarrh, also fibrosis. Small intestine.—Chronic catarrh and patchy congestion. Large intestine.—Considerable patchy congestion and catarrh. Abdomen.—Immensely distended.

Cause of death.—Broncho-pneumonia and bed-sores. General paralysis.

Microscopical examination of the brain (by Nissl method).— Ascending frontal and parietal, and parietal lobule.—Acute and chronic cellular changes, glia cell proliferation, increased vascularity, the perivascular lymphatic sheaths distended and filled with plasma cells, also a number of lymphocytes. The vessels in the same instances are quite empty and collapsed, but pigment granules of altered blood corpuscles can be seen both free, and in the proliferated cells of the sheath. Many of the medium and larger sized pyramids show changes resembling acute experimental anæmia produced by ligation of the cerebral arteries. The cytoplasm and nucleus are swollen, the latter is clearer than normal, eccentrically situated and surrounded by crumbling cytoplasm stained uniformly by fine dust like chromophilous particles. The processes of the cells are broken off and the cells are placed at all angles instead of in definite columns with their apical processes towards the surface. The small pyramids are similarly affected; only as a rule more cells have entirely disappeared. The intensity of the destruction varies in different situations in the same section. The cells of the molecular layer have entirely disappeared and there are numerous spider cells. There is cell proliferation, vascularity and thickening of the Some few of the Betz cells in the ascending membranes. frontal show marked chromolytic and nuclear changes. few are completely disintegrated, only a mass of very fine

granular cytoplasm remaining with crumbled edges. Besides the above portion of the cortex, the first and second frontal, Broca's convolution, central convolutions, posterior part of first temporal, angular and calcarine convolutions were examined. These all showed some of the changes described above, but the degree of severity of meningeal, vascular and cellular change is in the order mentioned, the changes in the occipital being very slight, for there is no meningeal thickening, and little or no abnormal vascularity, perivascular lymphatic dilatation or cell proliferation and but little dislocation of Meynert's columns. Some cells show chromolytic changes, but the acute changes are much less obvious than in the fronto-central convolutions. The changes noted above are in all respects like those met with in an ordinary fairly rapid case of general paresis.

GROUP 5.—Optic Atrophy and Tabo-Paralysis.

Case 58.—Tabes, optic atrophy. Herpes zoster twelfth dorsal, tremor of tongue and lips, speech affection. Paralytic dementia in a man aged 26, seven years after infection.—
(October 7, 1900, Charing Cross Hospital.)

R. M., aged 26. Labourer, previously leather dresser. No other neuropathic history, except uncle died in St. Thomas's Hospital of nervous disease. Married five years Christmas, three children alive, one dead, lived one month. Twelve months ago patient saw double, and since then has suffered with shooting pains in the head, arms and legs, and pain around back. Eight months ago, suffered with weakness in bladder, cannot hold his water. Six months ago had difficulty in walking, especially in the dark. Eight years ago, chancre which lasted three or four weeks. Treated with iodoform at the Lock Hospital. knowledge of any secondary symptoms. (It might be said that this was not syphilis, but I have seen so many cases treated for soft sore which afterwards developed brain syphilis, that I consider every venereal sore should be carefully watched and, if necessary treated. Only recently, within three months of infection, a case came to my out-patients', with optic neuritis and headache, and other signs of cerebral syphilis. He had only been treated locally. The patient recovered completely when placed upon mercurial inunction treatment.) Patient can stand with eyes shut and heels together, but cannot stand on toes. Cannot stand on left foot, but can on right. Knee-jerks absent. Pupils A.R., left 5 mm., right 4½ mm., and irregular in outline. Sexual desire lost four months ago, but was not excessive before that time. Tongue and lips tremulous; depressed anxious expression on face, and suffers with frontal headache. Articulation fairly good. Has shooting pains in the back of ear. Patient has not slept well, but has had no dreams.

Physical examination.—Old sear on dorsum of penis; glands shotty in neck and groins. Strength of muscles good. Marked hypotonus, extended legs can be moved to a right angle with body. Plantar, cremasteric and epigastric reflexes present. No loss of sense of position of hand. Tactile sensation good. In left foot and lower part of leg some pricks are felt as touch, or give the sensation of contact with a cold body. Pins and needles or shooting pains in legs and arms. No muscular wasting. Slight loss of sense of position of lower limbs. Some slight thermoanæsthesia in legs and both feet. Nearly blind in both eyes, but the left is more affected than the right. Primary optic atrophy both sides.

July 3, 1901.—Still pains in legs; quite blind. Expression emotionless. Marked tremor in upper lip and tongue, slight hesitancy in speech, but no slurring. Has no fits, but suffers with headache occasionally. Still complains of weakness of bladder. Can stand with heels together, but cannot stand on one foot; no ataxia in walking. Pupils right 5 mm., left 43 mm., both irregular in outline and inactive to light and pain, but react to accommodation and on convergence. On outer peroneal surface of right leg there is a patch of light tactile anæsthesia, a few spots scattered about on feet and legs where he does not appreciate a prick from a touch. Scars of herpes discovered right side area of twelfth dorsal. Superficial reflexes rather exaggerated. No thermo-anæsthesia. There is little change in sensory condition since he was here before. Although blind, he imagines that he sees people walking in at the door, and tries to get out of the way for fear of colliding with them. "He has got mixed in his speech for the past few weeks."

Case 59.—Ataxy, optic atrophy, loss of memory, melancholia, visual hallucinations, delusions about his food, death from tabo-paralysis.

W. B. H., age 45, single, draper's assistant, born in London, apprenticed at 16. At age of 30 contracted syphilis. Chancre (hard), followed by sore throat and falling out of the hair. He was treated for three months, but the gums were never sore. November 18, 1896, noticed dimness of vision of right eye, then

lost his sight in fourteen days. Previous to this he had insomnia for a long time. A few weeks later the vision of the left eye grew dim, and gradually became worse, until now he is almost completely blind. There is gray atrophy of both discs. His memory has not been good for several years. Four or five months ago he began to get weak in his legs; he is able to stand, but reels. There is no loss or delay of sensation to be detected in the limbs. The plantar and abdominal reflexes are brisk. The kneejerks are absent. There is no local muscular wasting. He is emaciating, but he does not refuse his food. He can get up himself. The pupils do not react to light, are small and irregular; they react when he is told to look towards his nose. He has difficulty in micturition, but this may be explained by the fact that he has a stricture.

Mental condition.—He has visual hallucinations, and is very depressed. Painted up women, perfumed, come to him at night and taunt him. His facial expression indicates mental depression; the lines are partially obliterated. The tongue is a little tremulous, there is no facial tremor. His memory of past events is fairly good, of recent events not good. There is a little hesitation in speech, but no syllabic difficulty. He cannot remember simple sentences which he is asked to repeat, e.g., one has to repeat word for word "The Irish artillery extinguished the conflagration," although he has not much difficulty in saying the words.

August 10, 1898.—He complains of shooting pains in the stomach and in the legs. He can localise sensation of touch and pain accurately. He knows when and how his great toe is bent. The knee-jerks are absent. The pupils are small, inactive to light, but react to accommodation. He has a delusion that he has never left Australia, and is still there, and he says that his sister has never been to see him, but that perfumed women come in to see him and make indecent overtures to him. His speech is slightly affected, being hesitant and tremulous. He says that his taste is good. Can hear a watch at one foot. No affection of taste, although he always says that there is something wrong with his food. He recognised salt and water perfectly.

Summary of notes of autopsy.—Dura mater adherent in front, pia-arachnoid is thickened generally, adherent slightly to the brain convolutions. There is some vascular effusion along the upper border of the hemisphere. Fourth ventricle is granular, there is general slight wasting of the cerebral gyri. The optic nerves are atrophied. Weight of brain $47\frac{1}{2}$ ozs. Heart, left ventricle slightly dilated, first degree chronic mitral disease and atheroma of aorta.

Microscopical examination (by Dr. Hamilton Wright).—Central and Broca's convolutions; pia-arachnoid is thickened and its vessels congested. Nissl's method shows Meynert's columns in a disordered state, and a marked atrophy of many cortical cells. The processes of the latter are "corkscrew" and are devoid of chromophilous granules. Glia cells are exceedingly numerous and there are many spider cells present. The vessels are congested. The whole appearance of the cortex is as usually seen in cases of early general paralysis. Tangential fibres in Broca's convolution and the part corresponding to it on the right side are wasted.

Spinal cord.—Lower cervical region.—About one half of the fibres have disappeared from the posterior half of the postero-Many of these in situ are in a state of chronic median columns. There is marked atrophy of fibres along the anterior half of each intermediate septum. This atrophy passes backward, at the same time decreasing in amount, into the inner aspect of the base of each postero-external column. There is a slight degeneration of fibres in the root zones. All these parts are the seat of a sclerosis proportionate to the fibre atrophy. The rest of the posterior columns are practically intact. The roots external to the cord contain only a small number of unsound fibres. The posterior spinal ganglion cells of this region are healthy looking. The fibres from their distal ends are not obviously wasted. Thoracic region —The fibre atrophy and consequent sclerosis have practically the same distribution here as in the cervical region. From the middle of the postero-median columns it tends to spread laterally into the median parts of the postero-external columns. There is a slight degree of fibre atrophy in both root zones and in the roots external to the cord. The posterior spinal ganglion cells are not obviously wasted. The most marked feature is shrinking, probably artificial in origin. Lumbo-sacral region.—Wasting of proper fibres is marked along the postero-median septum in the upper lumbar levels; also in the middle portions of the postero-external columns. In the lower segments the wasting has the same distribution except that fibres in the position of the median oval area of Flechsig are almost intact. These pass backwards along the septum and tend to spread out along the periphery of the cord. The root zones are obviously wasted and sclerosed. Fibres in the position of the cornu-commissural zone are almost intact. There is a marked degeneration and denudation of root fibres external to the cord. Those still present are only in a few instances sound. Most are in some stage of chronic atrophy. Many cells of the posterior spinal ganglia in this region are in a state of fatty

degeneration, and so give a purple reaction to Weigert-Pal hæmatoxylin. The peripheral ends of the ganglia contain only a few wasted fibres in marked contrast to the proximal ends.

It will be seen by the above that there is a moderate degree of wasting in, and a consequent sclerosis of, those parts of the posterior columns which contain exogenous or root-fibres. The endogenously derived tracts, i.e., the cornu commissural, descending comma, Flechsig's median, and Gombault and Philippe's tracts are practically healthy. The same may be said of the postero-internal zones. There is an intense congestion of all spinal, and spinal ganglion vessels. In the sclerosed areas these are slightly thickened.

Case 60.—Optic atrophy, followed by tabes dorsalis, and later general paralysis.

G. C., aged 36, porter, admitted May 27, 1894, to Marylebone Infirmary. Four years before admission began to suffer with giddiness, bad sight, and squint. One year ago began to suffer with a staggering gait and also dropping things, for which he lost his situation. Rheumatic fever several times. Denies syphilis. Jaundice twenty years ago, and at that time was crushed in a crowd, which caused him to be laid up for some time with a pain across his back. Gait staggering, but Romberg's symptom absent. He says he has difficulty in walking in the dark. Cutting pains in the legs, which are most severe in the left. Suffers with severe abdominal pains at times, probably gastric crises.

Eyes.—External squint of left eye. Movements outward incomplete. No reaction to light or accommodation. White atrophy of both discs. Knee-jerks present, ankle clonus. Tenderness over spine in the first dorsal, eighth dorsal, and lumbar region. Muscles good nutrition, no wasting. Sensation impaired all over face, chest, front, and both arms, with the exception of outer side of left arm; sensations to cold also slightly impaired; to heat, good. Leg sensation to touch almost absent, with the exception of the soles of the feet; sensation to heat impaired. Both feet and hands are very cold. Bladder, at times cannot pass water. Colour vision very imperfect; pink he calls yellow, violet black, cannot pick out green and calls it drab, chooses yellow correctly; picks out mauve as being the nearest approach to red. Seen by Dr. Beevor on October 27. The case was diagnosed by him as one of posterior lateral sclerosis, with prominent hysterical element. "The ankle clonus and generally increased reflexes were those of an organic lesion. The changes could only

be of similar origin. The alterations of sensation were probably almost entirely hysterical." Discharged December, 1898. For the above notes I am indebted to Dr. Lunn. Patient eventually died two years later at Claybury Asylum of general paralysis and septic meningitis.

Case 61.—Optic atrophy, preataxic stage of tabes several years, attack of mania, grandiose delusions, epileptiform seizures, death, characteristic brain lesion, arrested cord lesion of tabes dorsalis, degeneration of crossed pyramidal tracts, heterotopia.

J. W., age 37, agent, sent to me by Mr. Gunn from the Westminster Ophthalmic Hospital as a case of tabes in the preataxic stage in 1893; attended my out-patient department, Charing Cross Hospital, for eighteen months. During that period there was little change in his condition. He presented the following symptoms: Failing sight, concentric limitation of the fields of vision, small pupils, unequal, A. R. No ataxy, Romberg's sign not obtained. Shooting pain in legs, absent knee-jerks. Cutaneous sensibility was not noted. No signs of mental affection. I lost sight of him, but eventually I remembered the name when I was taking his blood pressure some considerable time after his admission to Claybury Asylum in December, 1896, suffering from mania and general paralysis.

Family history (from brother, December 5, 1898).—Father intemperate; no consanguinity, no insanity. Patient has lived a very fast life with loose women, and has suffered with syphilis; latterly has had business worries, and six months ago he was very depressed and threatened to cut his throat.

Physical condition.—Knee-jerks absent, walks with a shuffling gait, tremor of tongue and lips, speech slurred and syllabic, exalted expression.

Mental condition.—Impaired memory, no idea of time or place, indifferent to his personal appearance and surroundings, delusions of wealth.

The dementia continued and progressed, and he had many epileptiform and congestive seizures, in one of which he died, May 14, 1899.

Autopsy.—Nine hours after death. Body emaciated, left pupil 2 mm., right 3 mm. Legs are flexed at thighs and knees, there are large bed-sores over sacrum and great trochanters; he has numerous small, symmetrical, papery scars on both shins. The calvarium is thin. bloodless, frontal bone 4 mm., occipital

6 mm. The pia-arachnoid was markedly thickened over frontal and parietal lobes, and slightly adherent to the cortex; subdural space, moderate quantity of fluid. The basal vessels are the seat of a slight nodular arteritis. There is a slight wasting of first frontal and upper part of central convolutions on both sides. Cortical striæ are fairly well marked. The white matter and basal ganglia are slightly ædematous; no sign of softening or induration. The optic nerves on both sides are markedly atrophied. Both lateral ventricles are slightly dilated, full of clear liquid, and moderately granular. The fourth ventricle is slightly dilated, but markedly granular. The spinal cord showed no naked eye change. Weight of right hemisphere, 563 grammes, left ditto.

Lungs.—Bilateral septic broncho-pneumonia, which was the immediate cause of death. There is nothing further of note in the other organs.

Microscopical notes (by Dr. Hamilton Wright).—Brain.—The posterior third of each third frontal gyrus was examined and found to be almost denuded of tangential fibres. Quite eighttenths of them have disappeared. The cells are wasted and Meynert's columns disarranged. The pia is thickened and its vessels congested. There is a large increase in the number of glia cells. The whole cortex is like that seen in cases of general paralysis of moderate duration.

Spinal cord.—Cervical region.—The dorsal third of each postero-median column is slightly sclerosed. The sclerosis is most marked close to the median septum, and gradually diminishes in intensity as the intermediate septum is approached. The anterior third of these columns, except the apex, is also slightly sclerosed. A few fibres seem to have wholly atrophied in these patches of scar tissue. The great majority of those in situ, are irregularly swollen or attenuated. The postero-external columns along the outer side of the intermediate septa are slightly sclerosed, and a small number of fibres have disappeared. The most anterior parts of these patches of scar tissue widen out just before reaching the posterior margin of the healthy cornu commissural zone. There is no sign of atrophy in the fibres of the postero-internal zones. Charcot's root zones are intact in all segments of this region except the seventh and eighth. This is also the case in the extra-cordal portion of the posterior roots. In the seventh and eighth metameres there is a mild sclerosis and fibre atrophy in the root zones. A few fibres have disappeared from Lissauer's tracts. This, together with an atrophy of

fibres in the same positions in the upper few thoracic segments, is enough to account for the sclerosis along the external margins of the intermediate septa in the higher cervical segments. In both crossed pyramidal tracts there is a moderate fibre atrophy and replacement sclerosis; the intermediate gray matter through which the motor fibres course is intact. This appears to indicate that the degeneration in the crossed motor tracts is of fibres that end lower down in the cord. There is no atrophy in the anterior horns or roots. The central canal is normal. Thoracic region.— In the first two metameres the sclerosis of the posterior columns has practically the same distribution, and is of about the same intensity as in the seventh and eighth cervical segments. sclerosis below the second thoracic plane is slight and diffuse in the postero-median columns, except their most ventral parts. There is also a mild diffuse sclerosis of the median aspects of the postero-external columns. The eleventh and twelfth thoracic segments are, in addition to the above, slightly sclerosed in the position of the root zones and Lissauer's tracts. No fibre atrophy or sclerosis is observable in the postero-internal zones, the comma tracts, or the cornu commissural zone. The lateral columns show a gradually increasing sclerosis as the cord is descended. As in the cervical region there is no rarefaction to speak of in the intermediate gray matter. Between the fourth and eighth thoracic segments the central canal of the cord is singular. It is irregularly cross-shaped, with short, transverse, and long, antero-posterior arms. The short arms pass off on each side between the gray commissures, and present a small bulbous dilatation at their extremities. The long posterior arm has pushed the posterior gray commissure backwards into the median septum for quite a fifth of the length of the latter. The ventral-ward extension has been turned to the left by the base of the anterior median fissure. Surrounding the enlarged canal is a thick layer of gelatinous substance. The cavity is narrow and free of the débris so commonly seen in the adult human cord. An even, compactly arranged layer of columnar cells lines the inner surface of the gelatinous substance. At first it was thought this state of the central canal was due to accidental distortion of the cord during removal. But the layer of columnar cells lining the cavity is compactly and evenly arranged, which could hardly have been so had there been an accidental heterotopia. Moreover, the canal is greatly dilated in the lumbar region, and has a projection backwards capped by the posterior gray commissure, as in the thoracic region. It appears to be a developmental defect. Lumbar

region.—There is a moderate, evenly distributed fibre atrophy and replacement sclerosis in the posterior columns of this region. It has scarcely affected the posterior aspects of the external columns, or the apices, composed of cornu commissural fibres. The fibres along the median septum are more closely arranged, and there is less sclerosis amongst them than in the rest of the posterior columns. The root zones and Lissauer's tracts are slightly atrophied and diffusely sclerosed. In the roots external to the cord are a moderate number of partially wasted fibres. A few fibres have apparently wholly degenerated. In the lateral columns one may see a compact sclerosis of the motor tracts. It is much more marked than in either the thoracic or cervical regions. In this region there is a noticeable rarefaction of the intermediate gray matter. A few irregularly swollen fibres pass from the lateral columns into it. No wasted cells are to be seen in the anterior cornua. Sacral region.—This does not differ materially from the lumbar region. The sclerosis of the posterior columns is perhaps proportionately greater and more general. Charcot's root zones and Lissauer's tracts contain fewer fibres than in the lumbar segments. The extra-medullary portion of the roots are as in the lumbar region. The sclerosis of the crossed motor tracts is quite obvious to the naked eye, and is, under the microscope, fully as marked as in the lumbar region. The pia-arachnoid is slightly thickened between the points of entry of the posterior roots in all the levels of the cord. But there is no special concentration of it where the roots penetrate the cord. Throughout the cord the blood-vessels are slightly dilated and choked with red discs. In the patches of scar tissue the adventitia of the vessels appears to be slightly thickened.

Case 62.—Tabo-paralysis, commencing with optic atrophy, followed by slight ataxy, defective hearing, auditory hallucinations, deafness, history of fits, transitory aphasia, affection of taste and smell. Medullary, optic and spinal tabes, slight changes in cortex cerebri.

S. E. J., aged 32, admitted to Hanwell, February, 1896, on the following certificate:—"He is rambling and incoherent in his statements; says he hears voices at night, and they tell him he must get up. He is at times very excited and answers voices which are talking to him." Occupation carman. The following history was obtained from his wife:—

Family history.—Father deaf and dumb, died of asthma (?), mother alive in good health, one brother in good health. No history of insanity, intemperance or consumption in the family.

Personal history.—He enjoyed good health up to six years ago, when he complained of pains in his legs. A little later his sight began to fail. This, however, did not prevent him from following his occupation for some little time. He attended the hospital in Queen Square under Dr. Buzzard, and the appended notes indicate his condition in April, 1893, showing that it was a case of optic tabes, in which the patient remained for some time in a pre-ataxic condition. He has been very temperate, and there is nothing in his occupation which might have led to his illness, with the exception that he has had boxes of oranges and potatoes fall on his head on separate occasions, once eleven years ago, and again seven or eight years ago. The brain affection appeared to have commenced twelve months ago with fits.

The following are the notes of his condition when under the care of Dr. Buzzard, kindly supplied to me by the registrar:—

Admitted into "Queen Square" on April 11, 1893. For two years and five months, dimness of vision of left eye. For two years and three months, dimness of vision with right eye, and vision with left eye almost lost. For two years, vision with right eye almost lost. Lightning pains in lower limbs (2 date). One year and nine months, unsteadiness in walking. Nine months, shooting pains in back of head, both sides. One month, shooting pains across front of chest.

State on admission.—Gait slightly ataxic, also movements of arms. Shooting pains as above. Tingling in hands and feet. Sensibility to touch, pain, and temperature, good. Knee-jerks absent, also other tendon reflexes. Sphincters, unaffected. Vision, bad, only movement of objects. Right eye worse than left. Optic discs atrophic. Unequal pupils, loss of light reflex, nystagmus. Upward movement of both eyes and outward of left, defective. Hearing, right, \(\frac{4}{4}\), left, \(\frac{3}{4}\). Bone condition better on right side.

December 9, 1896.—He lies quite unconscious of everything around him. The attendant informs me that since I saw him, he has had many fits, which were more marked on the left side. Patient is greatly emaciated, and lies in bed with his legs drawn up, taking no heed of painful impressions, and apparently unconscious of his surroundings. When, however, food is placed near his lips with a feeder, he will suck at the spout, but does not

seem to distinguish between milk and a strong solution of quinine, which he takes equally well.

January 1.—Death from asthenia.

Present state (February, 1896).—He admits having suffered with syphilis before marriage. Physical condition.—His gait is not ataxic. He can stand with his heels together and his eyes closed. He is quite blind. The pupils are unequal, the right dilated, the left contracted, neither react to light. He suffers with pains in his arms, and he cannot touch the tip of the nose with his right forefinger, or make the two forefingers meet. He is deaf in both ears, but can hear loud shouting. There is nystagmus when told to look towards his right hand. There is no tremor of the tongue or face, but a little hesitancy and slurring of speech. He says he lost power of speech for some time last July. Examination of the fundus showed white atrophy of both discs, vessels normal in size.

Mental condition.—The memory is fairly good, but his intelligence is somewhat impaired. This may however be due to his blindness and deafness. He complains of hearing voices and sounds like bells ringing in his ears, especially at night.

July 8, 1896.—Progressive physical and mental enfeeblement. Painful sensation blunted, likewise taste and smell.

Abstract of notes of the autopsy from post-mortem book.—Pia-arachnoid opaque and thickened, especially over left angular gyrus. It is adherent to the brain substance in a few places. There is some congestion of the veins. Pia-arachnoid in the interpeduncular space is greatly thickened. Optic nerves are gray and shrunken. The lateral ventricles are dilated, but apparently not granular. The fourth ventricle is dilated and granular. There is a clot of blood outside the membranes in the lumbo-sacral region of the cord. The liver is fatty. Hypostatic pneumonia of the right lower lung.

Microscopical examination (by Dr. Hamilton Wright): Brain.—
The tangential fibres are almost wholly absent from the molecular layer of the central gyri. Most of the proper cells of the cortex are extremely atrophied. Glia and spider cells are greatly augmented. Spinal cord.—Vessels congested, great numbers of leucocytes, walls of arteries thickened. Cervical region.—
The posterior median columns show a marked scattered atrophy of fibres, about one half have disappeared; those in situ are fairly sound. On the outer side of each intermediate posterior septum is a band of sclerosis containing only a few fibres, all in a state of chronic wasting. This sclerotic band extends backwards

almost to the periphery of the postero-external columns. It is cut off from the commissure in its anterior aspect by fibres of the cornu commissural zone. Lissauer's tracts on both sides are almost denuded of fibres, and they have been replaced by scar tissue. The root zones of Charcot are deeply sclerosed. External to the cord the posterior roots are almost wholly atrophied. Many fibres remain in the bases of the postero-external columns, i.e., in the position of the postero-internal zones. The fibres of the cornu commissural zones are almost intact. There is a readily observable atrophy of the plexus of fine fibres in the upper part of Clarke's column. There is no atrophy of fibres in the lateral columns. Thoracic regions.—The greatest atrophy of fibres is in the root zones, and middle third of the posteroexternal columns. There is, however, as in the cervical region, a considerable scattered degeneration and replacement fibrosis in both postero-median columns. Lissauer's tracts contain many healthy fibres, but a chronic atrophy of some of them is obvious. Outside the cord the roots contain only a few fibres. The cornu commissural zone and the descending comma tracts are pervaded by a slight sclerosis, and appear to have lost a few fibres. The great majority are present, however, and are healthy. The plexus of fine fibres around the cells of Clarke's columns are few in number. There is no special fibre atrophy in the antero-Lumbar region.—Charcot's root zones are lateral columns. greatly sclerosed, also the middle third of the postero-external columns. There is a marked scattered degeneration throughout the postero-median columns. Most of the fibres in situ lie close to the median septum. The latter feature is well marked in the lower lumbar regions. The fibres of the cornu commissural zone are present in large numbers, and are mostly sound. In the roots external to the cord there is considerable atrophy of fibres, but this is not nearly so marked as in the cervical and thoracic regions. The posterior spinal ganglia contain many cells in a state of fatty degeneration; others are excessively pigmented and devoid of chromophilous granules. The cell capsules are markedly thickened. There is a marked sclerosis of the substantia gelatinosa centralis about the central canal of the spinal cord, in the first cervical segment, and where it opens out to form the calamus scriptorius. The floor of the fourth ventricle is likewise sclerosed, up to about the level of the striæ acusticæ. The post-pyramidal nuclei show changes. A few cells appear to have wholly atrophied, and most of those in situ are shrunken and closely embraced by the replacement sclerosis. There is total atrophy of the plexus of small fibres, and of most of the larger fibres, that usually surround or penetrate the nuclei. A marked atrophy is observable of the internal arciform fibres and fibræ rectæ, and there is a noticeable substitution sclerosis in the raphé. On both sides the nucleus arciformis is denuded of fine fibres, and its cells are shrunken. None of them, however, seem to have disappeared. In the corpus restiforme there is a slight diffuse sclerosis, with more marked islets here and there. It is possible that this is due to an atrophy of the continuations of the wasted arciform fibres. There is an almost entire absence of fine fibres from amongst the cells of the tenth, eleventh, and twelfth cranial nuclei. It is difficult to decide if there has been an actual destruction of any cells. Those present are shrunken and closely surrounded by an increased amount of sclerotic tissue. The degeneration in the intramedullary portion and in the stumps of the tenth pair of nerves is striking, but it is more marked on one side than the other. About one third of the more deeply implicated nerve has wholly atrophied. The complete atrophy of fibres is not so marked on the opposite side. Many of the fibres still present on both sides are irregularly swollen. In both the stumps and intramedullary portions of the nerves there is a considerable replacement sclerosis. hypoglossals pass ventral-wards to escape from the bulb, and in the stumps of their trunks, a few degenerated fibres may be observed. One of the most interesting features about this case is the atrophy in the nucleus ambiguus, or accessory vagal nucleus, and the solitary fasciculus on both sides. In the nucleus on both sides there is a marked atrophy of the fine plexus of fibres amongst the cells and of the fibres that compose the stalk. The more deeply implicated nucleus and stalk is on the same side as the more atrophied tenth nerve. Beyond doubt the marked atrophy in the tenth nerve is in part due to the atrophy of those fibres of the accessory vagal nuclei which enter into their formation. The vertical fibres of the solitary fasciculi are obviously wasted on one side only. On both sides the plexus of fine fibres in the surrounding gelatinous gray matter are wasted, almost wholly on the side where are the atrophied vertical fibres, and moderately on the side where the vertical fibres are intact. The more degenerated fasciculus is on the same side as is the least affected accessory vagal nucleus. Strands of fibres pass from both fasciculi to the intramedullary trunks of the tenth pair of nerves. They are not obviously wasted. In the ascending roots of the fifth pair of nerves there are a few wasted fibres and a moderate amount of sclerosis.

Case 63.—Optic atrophy and blindness at 28, preataxic stage eighteen years, ataxy for a long time, preceded by mental symptoms, several fits, hallucinations, and delusions of persecution, progressive dementia.

J. M., aged 48, metal polisher. Wife has known her husband since the age of 18. Patient's mother died suddenly of a paralytic He was very unsteady before the age of 21, when he married. Since his marriage, patient has drank. A son was born twelve months after marriage, and his wife had a miscarriage two years afterwards, and no children since. The son was healthy, but died aged 22, of diphtheria. At the age of 28 (1880), patient began gradually to lose his sight, and he became completely blind in about twelve months. The doctors told him that he had "white atrophy." At this time he was mentally unstable. During the last two years (1898-1900) patient's legs have seemed to give way under him a little. He used at different times to pray, swear, &c., but never wandered from home. He finally squandered his money and "should not have had the handling of it for a long time before this." Patient had a fit in December, 1898, and was admitted to Bethnal House, from which institution he was discharged in September, 1899. He was at home for five weeks, and during this time whilst in a fit "put his head through a pane of glass." He had weakness of the right side, and was very shaky afterwards. Before he had been at home a fortnight "he began to be afraid, and wanted to go back to the asylum." He was admitted to Claybury on November 8, 1899, and was certified as follows: "Aspect vacant and smiling, quite incoherent, does not know where he is, can give no account of himself, wishes to die, answers imaginary voices, has been noisy, shouting 'murder' and 'police,' and saying voices accuse him of stealing." On admission, the speech, tongue, lips and facial muscles were tremulous, the pupils were fixed and irregular, the right being slightly the larger, he was quite blind, and slightly deaf, and the knee-jerks were absent. He was depressed and very emotional when spoken to, he had delusions of persecution, and said people were trying to poison him. He was very confused.

Further notes.—March 21, 1900.—Knee-jerks absent, sensation apparently normal, stands and walks very well for a blind man, pupils irregular and immobile, 3 mm., the right slightly the larger, slight wobbling nystagmus, white atrophy of discs, memory very good, knows the day and year on which he was

born, his age, period of blindness, &c., and says he has been here twenty weeks all but two days. Knows the present date, &c.

October 23, 1900.—Knee-jerks absent, hypotonus to within 20° of the vertical, right pupil very irregular, and left somewhat irregular. They vary in size around 3 mm., sometimes the right and sometimes the left being the larger. The speech is tremulous and jerky, and drawling and typical of general paralysis. The tongue is very tremulous, there is right facial paralysis, and the right hand is slightly paretic. He is exceedingly dull mentally, and anxious to go home.

November 16, 1900.—There is hypotonus to within 15° of the vertical in both legs. The right pupil shows most irregularity, and is slightly the larger. There is marked tremor of the tongue and face, and the speech as before is typical of general paralysis. There is some right facial paresis, but no weakness of the arms. He is very active on his legs considering his condition. He feels "all right" and happy. He remembers quite well recent and remote events, and the present day and date. He knows "as he has a memory." He is very impatient of control, and dislikes being examined as "he is blind, and it is therefore unnecessary."

January 4, 1901.—He is now an advanced general paralytic, both the pupils are irregular, the right $4\frac{1}{2}$ mm. and the left 3 mm. He is now very feeble and cannot stand or walk. He sits all day in a chair rubbing his hands over his head, or one hand against the other (he was a metal polisher). To questions, he drawls, "I'm all right," or "I forgits," he is restless and irritable if interfered with, wet and dirty in his habits, and quite helpless.

February 10.—Death.

Abstract of port-mortem.—Summary.—Gross signs of general paralysis with sub-dural hæmorrhage, old-standing optic atrophy, syphilis probable but not positive, bladder hypertrophied, acute cystitis, broncho-pneumonia.

Morbid histology.—Microscopical examination of the brain by Nissland other staining methods for showing fibres exhibited the ordinary characteristics of advanced progressive paralysis. The spinal cord and cauda equina were examined by the Weigert and Pal methods. (1) Cauda equina.—Marked congestion of veins otherwise no change in the vessels or their roots. Diffuse atrophy an denudation of fibres in nearly all the bundles, both anterior and posterior but especially of the latter. Some degree of substitution fibrosis but not equal to the atrophy. (2) Second sacral and surrounding roots.—Atrophy of attached posterior roots, diffuse degeneration of exogenous fibres in posterior columns and cornua,

escape of endogenous fibres. Slight sclerosis in crossed pyramidal (3) Fourth lumbar.—Ditto. Crossed pyramidal degeneration much more marked; anterior roots show no obvious atrophy; posterior roots, on the other hand, fairly marked atrophy, one-third to half the fibres gone; diffuse but pronounced degeneration with neuroglia substitution of exogenous systems, with escape of the endogenous; anterior horn cells unchanged except for some chromatolysis. (4) Tenth dorsal.—Slight degeneration of posterior roots, more marked on one side. Slight atrophy of fibre plexus of Clarke's columns, degeneration and atrophy of fibres in middle of postero-external column, and of fibres proceeding to form Goll's column, viz., middle and long fibres are degenerated in proportion to affection of the posterior roots of the lumbo-sacral region. There is some atrophy of Lissauer's tracts proportional to the atrophy of fibres in roots. Eighth dorsal.—Ditto. The pyramidal tracts do not appear to be so obviously sclerosed as in the lumbar region. Sixth dorsal.—Ditto. Seventh cervical.—No degeneration of posterior roots, diffuse degeneration and sclerosis of Goll's column, slight degeneration and light diffuse sclerosis in tract lying outside of Goll's column and corresponding to fibres from first dorsal and eighth cervical. No obvious degeneration of pyramidal tract commensurate with what is seen in the lumbar region. Second cervical.—Ditto. No obvious degeneration of direct tract at this level or elsewhere.

GROUP 6.—Conjugal Tabes and Paralysis.

Case 64.—Conjugal tabic general paralysis, history of injury to head when a child, damage of prefrontal region of left hemisphere. Illness commenced with optic atrophy and blindness, followed by visual and auditory hallucinations, delusions, ataxy of arms, and progressive dementia. Death from acute attack of recurrent dysentery. A large depression due to loss of substance of anterior portion of second and third frontal convolutions left hemisphere. Typical appearances of general paralysis of brain. Naked eye sclerosis of posterior column. Atrophy of the optic nerves.

M. M. C., widow, aged 38. Admitted to Claybury, June, 1901. Husband, a soldier, latterly worked as carrier, who had fits, and finally went out of his mind and died in Shoreditch Infirmary. She was married a long time ago while she was in service. She has had no children and no miscarriages. She says that she has had a lot of trouble. Between 6 and 7 years of age she had a fall from the balcony, and there is a depression the size of a

shilling on the forehead 13 in. above the centre of the left orbit. Her memory is very bad. She has had a feeling of a tight belt round her waist, and still possesses it. She has been unable to unbutton her clothes for some time past. Her speech is hesitant and slurred, there is slight tremor of the facial muscles, also slight tremor of the tongue. She says that she has had several times attacks of sickness. Pupils 6 mm., regular, inactive to light and pain. White atrophy, with cupping of both discs, vessels normal in size. Expressionless face, except when talking, when she is frequently moved to tears or laughter; she is very restless and difficult to examine. Continuous restless movement of the hands; no fits, says she has wasted. Knee-jerks + + right side, absent left side, plantar reflexes + epigastric + +, no hypotonus in the legs. Skin sensibility.—Very difficult to test, apparently hypalgesia from third to the seventh segments inclusive. Some loss of power of localising, as she does not always put her finger accurately on the spot pricked or touched. Says that she has frontal headache, sometimes very bad. She has had a deal of worry. She does not care about food much, and is troublesome about it. Urine normal, temperature subnormal. She is very restless at night. The certificate stated that she was restless at night, and believed people came into her bed. She hears voices.

History of patient (from mother).—Her daughter was married twelve years ago; the husband had been taken to Shoreditch Infirmary because he was out of his mind, he was too ill to move to an asylum, and he died there. She believes that his mental complaint was brought on by worry, owing to his wife becoming blind, and his losing his place at Carter Paterson's. He had been a long time in the army prior to marriage, and had served in the Artillery. He had been to India, and was said to have had sunstroke there. For years previously to his death he had been irritable, but after his wife becoming blind, he had treated her kindly. He was a tectotaler for years, but latterly had occasionally broken out in drinking. He had latterly several fits. There is no history of insanity in the patient's family, with the exception of religious craze (revivalism) in the grandmother; she was not, however, put into an asylum.

Dr. Macmillan informs me this patient was the subject of visual and auditory hallucinations.

During her stay in asylum her mental condition was one of depression. She rarely spoke to anyone; she was very suspicious, and had delusions of persecution. She would do nothing she was told, had to be dressed and had to be fed, as she believed her food was poisoned. She frequently complained of feeling "bad smells," and would often pull her clothes tightly round her and remark, "I'm in such a mess." She always complained of being dirty, and wanted to be washed. During the first three months of her stay here, she had the delusion that she was pregnant, but latterly seemed to have got rid of it. In January, 1902, she was transferred to the hospital for nine days, as she was suffering from an attack of dysentery. While there after the first two days she was much brighter, and developed the delusion that she possessed a large fortune. At the same time she was noticed to converse with "voices." She would sit up suddenly in bed, open her eyes and gaze at the ceiling, and, stretching her arms out, would say, "I am coming." often call on "Harry," and remark, "I will be with you soon." At times during her imaginary conversations, she would burst out laughing, as if amused by something she had heard. When allowed up, she would sometimes get up and walk across the ward, because she heard some one calling her to do so. If anvone spoke to her, she never turned her head towards them, but gazed up straight in front of her.

Abstract of post-mortem notes.—Patient died on April 15, 1902, eleven days after admission to Hospital from an attack of acute dysentery. The certified cause of death was, "Acute dysentery supervening on chronic."

Main facts of interest.—No external signs of syphilis on the body. Scar, the size of a threepenny piece on the cervix uteri close to junction with vagina which might have been the result of a primary sore. There was a hole the size of a sixpence in the region of the left frontal eminence closed by dense fibrous tissue to which the dura and pia is adherent. On removal of the brain the dense fibrous tissue had to be cut through and it was found there was a considerable loss of brain substance in the anterior part of the second and third frontal convolutions, the cavity extending nearly to the orbital surface of the lobe; it was large enough to have held half an ounce of fluid. There is almost generalised thickening and opacity over the pia-arachnoid of the anterior two-thirds of the hemispheres. There is some wasting of the convolutions in these regions. There is not much dilatation of the lateral ventricles. Ependyma granular, fourth ventricle very granular, especially about the calamus. After hardening in Müller fluid, naked eye degeneration of the posterior columns of the cord, with moderate atrophy of the posterior roots, especially the lower cervical and upper dorsal, and lumbo-sacral. Marked gray atrophy of both optic nerves. Sections stained by Weigert method showed the usual degeneration of posterior roots and posterior columns of an early case of tabes.

Case 65.—Conjugal paralysis.—Husband syphilitic, wife married twice, no children by second husband; the former died of taboparalysis, the latter a short time after of ordinary paralytic dementia.

G. S., aged 43, docker, admitted to Cane Hill Asylum, July 19, 1899.

History.—Patient became gradually blind about two years ago, and subsequently suffered with locomotor ataxy, which took him to Stoke Newington Workhouse, where he remained one year. He then developed an attack of acute mania, becoming restless, excitable, and violent, threatening to stab another patient; he was certified insane. On admission to Cane Hill it was found that his wife was already in the asylum suffering from general paralysis. The following facts were elicited from friends: He did not drink, nor was there obtainable any hereditary history of insanity. He lost his sight gradually, and this was followed by drooping of the left eyelid, his mental state denoted considerable dementia and loss of memory, with defective knowledge of time and place; he has no delusions of grandeur or persecution, but is restless, noisy, and delirious, and although blind, has frequent visual hallucinations.

Physical condition.—He has a fatuous expression, the face is congested, the skin greasy and there is incomplete ptosis of the left eye (see photo., fig. 37). The pupils are unequal, dilated and irregular; there is primary optic atrophy of both discs and there is tremor in the lips and tongue, but not marked; the speech is somewhat hesitant and slurred; his gait is shambling; he brings his heels down first and he walks with a wide base, but there is no marked ataxy; the knee-jerk is present on the right side, absent on the left. He is too demented to give any reliable answers in regard to cutaneous sensibility; there are well-marked signs of syphilis on the body in the form of a scar on the glans penis, enlarged inguinal and cervical glands and tissue paper scarring all over trunk and limbs.

When asked about his wife, he says he does not know where she is and doesn't want to; she was brought to see him and she was much affected, but he was quite indifferent and told her to go away; he became more demented and died in December, 1899. E.S., his wife, aged 39, had one child by her first husband, but no children by her present one; her illness began with a fit a short time before admission; she was taken to Guy's Hospital and thence to the infirmary, has had no fits since.

Mental condition.—She exhibits considerable dementia and is depressed, especially about her husband; the photograph shows this in her expression as compared with that of her husband.

Physical condition.—Pupils equal, react to light sluggishly; react well to accommodation. She can walk about, tries, though feebly, to make herself useful in the ward. Tremor of the tongue and lips, and slight paresis of the right side of the face. Speech is very tremulous and syllabic. Knee-jerks exaggerated both



Fig. 37.

The physiognomy of the man denotes mild exaltation and dementia, that of the woman slight depression.

sides. The disease progressed, patient becoming gradually more demented; the tremor and speech affection more marked. The mental depression gave place to mild exaltation, and eighteen months after admission she died from exhaustion, following epileptiform seizures.

Post-mortem notes (abstracted).—An old scar found on the outside of the right thigh (? gumma), and cicatrix on the cervix uteri were the only signs which could possibly indicate syphilis. Body, well-nourished; brain, dura mater, non-adherent; considerable amount of fluid in sub-arachnoid space. Left hemisphere weighed 14 ozs., right hemisphere weighed 17½ ozs. The wasting of the

left hemisphere was especially marked in the prefrontal and central convolutions. The same applies to the right, but less marked. The pia-arachnoid is thickened, adherent, and opalescent. Both lateral and fourth ventricles are granular, and the left ventricle is much larger than the right, corresponding to the difference in weight of the hemispheres. There is early atheroma of the aorta, but the cerebral vessels are normal.

Post-mortem of G. S. (husband).—Died five months after admission. (Abstract.) Brain; pia-arachnoid thickened, especially over the frontal and central convolutions; atrophy of the left superior parietal lobule. Over the inferior surface of the orbital lobes on both sides, the brain substance, and the pia-arachnoid covering it, has an appearance not unlike that of a cirrhotic liver; on the mesial surface and tips of the prefrontal lobes, there is marked pia-arachnoid thickening and wasting of the convolutions. The lateral ventricles are not much dilated; the ependyma is somewhat granular; the fourth ventricle is dilated and very granular; Broca's convolution shows very little wasting; the pia-arachnoid strips with few erosions, the gray matter of the cortex is diminished, and in the lower part of the central convolutions the cortical striæ are ill-defined. Both optic nerves are greatly wasted. Left hemisphere weighs 19 ozs., right 19½ ozs. Pons medulla and cerebellum 7 ozs. Aorta was markedly atheromatous.

Death was caused by gangrenous pneumonia.

Microscopical examination of the brain (by Nissl, Marchi, Marchi-Pal and Weigert methods).—Sections were taken from (1) ascending parietal, (2) second and third frontal, and (3) orbital. Summary of results.—The changes are mostly of a chronic degenerative character in all the areas examined; few cells were acutely changed. The most marked acute changes in the cells are in the orbital region, where the vascular changes in the form of stasis and perivascular cell proliferation are most pronounced. The neuroglia cell proliferation is nowhere very marked. Recent degenerated radial fibres are seen in the central convolution by Marchi method, but none in the tangential or supraradial fibres. By Marchi-Pal and Weigert methods these layers of superficial association fibres are greatly diminished or absent in all those regions examined. The changes correspond to an ordinary slowly progressive case of dementia paralytica.

Examination of the spinal cord, ganglia and roots (by Marchi, Weigert-Pal, and Nissl methods).—By the Marchi method, sections of the cord in the cervical region at different levels showed a large

number of degenerated fibres scattered about in the posterior columns, also in the crossed pyramidal tract on the right side and the direct of the left, showing that there was a recent degenerative process occurring in the brain.

Different levels of the cord in the cervical, upper, middle, lower dorsal and lumbo-sacral regions were examined by the Weigert-Pal method. Sclerosis of the right crossed pyramidal tract and of the whole posterior median column was found in the cervical region. In the dorsal region there was degeneration in the postero-external column corresponding to Charcot's root zone. This was especially obvious below the eighth dorsal. It seemed in this region that the degeneration and atrophy of fibres was more obvious on the side opposite the degenerated pyramidal The sections were cut to include the roots, and sections at one level would show far more degenerated fibres in the roots than at another level. The degenerated roots would be sometimes more apparent on one side than the other. Lissauer's tract generally showed diminution of fibres, but it varied at different levels. In the lumbo-sacral region, sections showed atrophy and denudation of fibres throughout the posterior column, except in the oval area of Flechsig and the cornu commissural zone. As in the dorsal region so here, the atrophy and sclerosis of roots is the subject of considerable variation, and is nowhere complete.

Spinal ganglia (stained by Weigert method) cut in series.—
The cells show in great part some protoplasmic change, for they have a blue appearance owing to the presence of fine stained granules. The nerve-fibres leaving the ganglion show considerable atrophy and sclerosis. In the capsule of the gland, and in the distal roots, a number of bundles of fine medullated nerve-fibres are seen, which are either deficient in fibres or are unstainable. The third lumbar, stained by Nissl method (serial sections of this ganglion being made).—All the sections showed a variable number of cells presenting change from slight chromatolysis to a very marked condition of the same. In many of the cells the nuclei are eccentric and hardly stained at all.

Vascular and meningeal changes.—The changes in the meninges are not extensive, and although they are somewhat thicker over the posterior column of the cord, still there is not a marked flattening as is found usually in a prolonged chronic case. Nowhere could a process of endarteritis be seen, and the thickening of the vessels would in no way explain the atrophy of the fibres. The sections of the cauda equina show that the vessels in the undegenerated anterior roots were as often thickened as

those in the posterior, and in no case was an artery found blocked. Congested veins were found equally in both degenerated and undegenerated roots.

The retinæ and optic nerves were cut in celloidin and stained by logwood and eosin, by Ströbe and Weigert methods.

The retinæ exhibited no inflammatory changes or alteration of the vessels. The ganglion cell and nerve-fibre layers were entirely absent. The rods and cones were not distinguishable, but there was undifferentiated protoplasm, stained with the logwood, lying between the hexagonal pigment cells and the granular layers, which are intact. The sustentacular fibres of Müller were very distinctly seen owing to the absence of the ganglionic layer. There was considerable excavation of the papilla.

The optic nerves were shrunken to half the normal size. The nerve-fibres were absent, their place being occupied by a fine meshwork containing a large number of round and oval granular nuclei or cells. The interstitial septa are thicker and more obvious than usual, and contain also a number of proliferating cells or nuclei. The vessels show no apparent change or only slight thickening of their walls.

Case 66.—Conjugal paralysis. Husband suffered with fits, hemiparesis, and dementia, sluggish pupils; diagnosed by Dr. Bailey and Dr. Alexander as probable general paralysis. Wife admitted with acute mania and died of tabo-paralysis.

L. H., aged 54, admitted to Hanwell, January 11, 1901, suffering with acute restless mania.

History (from daughter).—Worried about her husband's illness, and for the last two years has been strange, easily excitable and always talking about her troubles. The husband had a fit two years ago, since then unable to do any work, and this preyed on her mind. Two months before admission she had a fit followed by left-sided hemiplegia of a transitory character, she remained in bed three weeks, after this she was able to walk about as before. She then became restless and strange, getting up in the night to hide things, wanting to buy all manner of things, going out of doors and talking to strangers about the way people treated her, untidy in her dress and dirty in habits.

When I saw her four days after admission she was in a state of acute mania resembling alcoholic mania, but there was no history of intemperance. There was a history of three successive miscarriages, and the notes state of syphilis. This was probable

from statements made in her delirium. She kept repeating, "he poxed me-my son must be cut like a Jew." She says she dreams all manner of things, she sees Old Nick. She says that they have put poison in her feet, legs, and arms. She says burglars came into the house, they boiled the pot and then poured it down her She thinks she is at Crawford Street still. going to be married and wants clothes of gold. She does not recognise the nurse or doctor. She has not been to the closet for three months; the food is poisoned. Continuous restless motile delirium, and tears up her clothes. Sings and shouts and hardly sleeps at all while in the padded room. She was brought to the asylum tied on a stretcher.

Physical condition.—Emaciated, no teeth, knee-jerks absent, tenderness of the calves when compressed, pupils unequal R. > L. $4\frac{1}{2}$ mm., 4 mm., speech a little slurred and hesitant.

March 17.—Mania still, but not so marked, yet restless, excitable and full of delusions about valuable ornaments and gold watches, frequently takes her clothes off, and is very troublesome. Arteries atheromatous; aortic regurgitation, collapsing pulse, acute mania of general paralysis diagnosed.

March 28.—Mania subsiding, orientation in time and place very imperfect. No tremor of tongue, articulation fair. Pupils irregular, dilated, equal inactive to light, sluggish to accommodation. No tenderness on pressure of legs. Knee-jerks absent. She now knows her friends and talks to them, but memory very poor.

October 30.—She is now a well pronounced general paralytic. Dr. Bailey saw Mr. H., the husband, he is partially demented, pupils unequal, sluggish reaction to light, speech slow and hesitant; history of several paralytic seizures. Dr. B. considered that the patient was a general paralytic.

November 28.—Much weaker, confined to bed; sometimes hardly speaks for weeks together. To-day she was more talkative. Knee-jerks absent. Triceps-jerks easily obtained. Lies in bed with hips and knees semi-flexed, but feet plantar-flexed and somewhat inverted. She does not take any notice of sharp pricking of the legs, nor of a strong faradic current, but she immediately does when the arms are stimulated or pricked. All the muscles respond to faradism. Plantar and epigastric reflexes obtained with great difficulty.

December 6.—Right-sided epileptiform convulsions.

¹Subsequently I ascertained from a doctor who treated the husband that he had had syphilis.

December 13.—Death. Pupils unequal, right 5 mm., left 6 mm. Post-mortem.—Body much emaciated. Left hemisphere subdural hæmorrhage about one week old. No naked eye softenings, Right hemisphere 18 ozs., left 18 ozs., cerebellum and pons 5 oz. Sub-arachnoid fluid increased. Ventricles somewhat dilated, granular ependyma, especially lateral sacs of the fourth ventricle. Pia-arachnoid thickening over frontal and central convolutions especially. Some atrophy of convolutions. Typical appearances of early general paralysis. Aorta atheromatous second degree, and aortic valvular incompetence. Spinal cord—after hardening in Müller—showed well-marked posterior and lateral column degeneration.

Case 67.—General paralysis (tabetic), wife suffering from locomotor ataxy. Impaired cutaneous sensibility to pain on the left side after a series of epileptiform seizures. Death one year after admission.

W. F., aged 38. Occupation journalist, admitted to Cane Hill, December 6, 1900, first regarded as an epileptic. He came from Lambeth Infirmary under the following certificate:-- "Strange in manner and states that he is starved here (a delusion); states he wants to go to South Africa at once before Roberts and De Wet finish; that he has the editorship of a leading paper there; says that he has a comfortable home there to go to, and plenty of money. The wife states that there is no home now." There is no history of insanity, phthisis, or alcohol. He has been married nine years, no children, one child born dead eight or nine months after marriage, denies syphilis, but there is a scar on penis and indurated glands. His illness commenced two years ago with a fit. At the end of January the patient had a series of left-sided epileptiform seizures which according to the attendant began in the angle of the mouth and spread over the left side. He does not lose consciousness but becomes drowsy. I saw him in June, 1901, for the first time. The attendant informs me that the wife, who lives at Sheffield, had visited the patient and he had noticed that she walked with a characteristic ataxic gait, and she told him herself that she had suffered for some few years past from the same disease, locomotor ataxy. Patient is lying in a semi-stuporose state being affected with a congestive seizure, so that he is incapable of examination.

July 5.—Patient is now up and walking about. The following notes were made:—

Physical condition.—There is no ataxia in his gait and he can stand with his eyes shut; grasp good both sides, and there is no muscular weakness. No loss of sense of position in the hands or feet, superficial reflexes rather exaggerated, knee-jerks absent both sides, triceps-jerk and wrist-tap contraction easily obtained, no affection of speech or handwriting, tongue slightly tremulous, somewhat expressionless face except when conversing. Pupils equal, 3½mm., a little irregular outline, do not react to light or pain, react to accommodation. The last time I saw him the pupils were unequal, the left being the larger.

No trouble with the bowels or bladder.

The attendant says that he has had several left-sided seizures since I saw him, which last about one and a half minutes. In one, the attendant saw him go to the left in falling "like a peg top." Some hypotonus in the legs, rather more marked on the right than the left side.

Sensory.—Cutaneous Sensibility.—All over the left arm and leg and left side of trunk are spots in which prick of pin is not felt, or only as a touch; there are also spots of tactile anæsthesia. He was tested in the following manner, stripped and eyes blindfolded. He was told to touch with his finger the part pricked or touched. This he invariably accomplished accurately and without delay on the right side, not so, however, on the left. Sometimes he localised wrongly, sometimes he did not feel at all the prick of a needle or touch with finger. There was no precise root area determinable except over the left buttock and around the anus on the side that the defective sensibility was most marked. No loss of joint sensation could be determined. He has no hemiparesis. Smell and taste.—Thinks asafætida smells like violets, cannot smell rose water or strong peppermint. He did not recognise acids, salines, or syrup, but recognised bitters when quinine was painted on the back of the tongue. There is no limitation of the field of vision, and his colour perception is good enough to pick out the ordinary colours. Hearing.—Hears a watch at 18 ins. from both ears.

Mental State (October 15).—Patient is fairly coherent, except when suffering with conjective seizures. He has had hallucinations of vision, seeing people lying alongside of him and annoying him. He is said to have had delusions with regard to his bowels. He can give a fairly rational account of himself, and I could find no gross loss of knowledge of time or place. He says that he has had no pains in the legs and no feeling like a cord round the waist.

January 13.—Death took place.

The brain showed well marked signs of general paralysis in the

first stage. First stage of sclerosis in posterior column. Wife was seen by Dr. Cribb, and he found her to be a well-marked case of locomotor ataxy. She had attended Queen Square for some years for this complaint. I wrote asking her to come and see me, but she did not turn up.

Case 68.—Conjugal tabo-paralysis of an aged couple (the melancholic type). Wife affected after the husband, rapid course of the disease in both cases.

E. E. G., admitted to Claybury, December 14, 1900, died October 19, 1901, aged 64 years; occupation washerwoman, moderate drinker.

Family history incomplete, husband a carpenter in Woolwich Arsenal, afterwards pensioned, was several years in the Volunteers, died in Barming Heath Asylum, July 26, 1899, after two years and four months residence, aged 64 years. Had two fits before he went away, and one later. He went blind while he was in the asylum, he was said to have "paralysis of the brain," or "general paralysis." Patient was married forty-five years, she had in all eighteen certain conceptions, two boys and five girls are alive and healthy. She had at least five still-borns or miscarriages, all the rest died as babies.

History of attack.—Patient grieved very much when her husband was taken to Barming Heath, but she kept fairly well Twelve months before admission she mentally for some time. became suspicious and strange in her manner; "one time said she was not at home and got her things, and said she was going home," very restless at night, began to "talk funny and say senseless things," used to hear voices about. If she had money, "they never knew where it went"; she thought "robbers were getting into the house," and "there was a cellar below, and children were crying in it." She could not be left alone; "one night she got out and had a clock under her arm and a cup of tea in her hand, and said she was going home." Her husband had been a very similar case, and as he had done, so used she to cry for hours at a time, and say that everyone was hard on her, and no one did anything for her, and also that she never had any money, and was not at home. Some months later she fell down in the back garden, and could not speak for twelve hours, but seemed to have no paralysis. She was then in bed for about six weeks. After this she was up for about a month, during which time she began to wander about as before, or worse, and finally was sent away.

Certificates.—Very talkative, restless, and incoherent, is constantly getting in and out of bed at night, wandering about, talking to imaginary persons, and quarrelling with other patients and pulling them about.

On admission.—Serpiginous ulcer on outside of right knee (diagnosis syphilitic), scar on left leg, bronchial râles in chest. Memory much impaired, depressed and miserable, gives a confused account of her past life, sees strange persons about her bed, wet and dirty in her habits.

January 3, 1901.—Knee-jerks absent, right pupil 2, left $1\frac{2}{3}$, they accommodate to $1\frac{2}{3}$ and $1\frac{1}{3}$, right (?) irregular, left irregular, no reaction to light, very little tremor of tongue, speech not characteristic, talks rather sensibly but is demented, is occasionally wet.

March 10, 1901.—Brighter but memory remains defective.

September 10, 1901.—Palate high, teeth very good for age, considerable tremor of tongue, voice very tremulous and hesitant, and characteristic of general paralysis, right pupil $2\frac{1}{3}$, left 2 minus, accommodate to 2 and $1\frac{1}{3}$, both knee-jerks absent, left foot has a sore on the outer malleolus, and is redder and colder than right. The ulcer on the outer part of the right knee has healed leaving a serpiginous pigmented scar. Patient is in bed and very feeble. She is very emotional and cries when her husband's name is mentioned. She remembers my face though she has not seen me for eight months.—(F. W. M.)

October 19, 1901.—Died of exhaustion.

Post-mortem.—External appearances as described above. Skull.—Considerable hypertrophy of inner table in frontal region, and dural adhesions. Right pupil 4 mm., left 3, no definite signs of optic atrophy, but the left is a little smaller and grayer than the right. Great excess of subdural fluid. Pia-arachnoid, there is considerable fronto-parietal thickening and milkiness, much congestion, sub-pial extravasations on right pre-frontal region and scattered over left frontal region. Mid-line pre-frontal adhesions, which decorticate on stripping, slight excess of sub-arachnoid fluid, basal vessels much dilated, and internal carotids highly atheromatous. Weight of encephalon 1380 grammes, right hemisphere 575, left 580, cerebellum and pons 170. Moderate pre-frontal wasting, lateral ventricles much dilated and granular, third ventricle granular, fourth ventricle granular throughout. The whole of the encephalon is congested and the sinuses are full of blood-clot. Lungs emphysematous and cedematous, heart flabby and full of dark clotted blood, cavities dilated, mitral valves slightly atheromatous, one or two specks of early atheroma in coronary arteries, a relatively little amount of second stage atheroma in the aorta and a few pearly white patches, which are more frequent in the abdominal aorta than in the thoracic. Liver congested but otherwise natural except for a little scattered fatty degeneration. Spleen small and diffluent; kidneys, capsule slightly adherent, congested, cortex 4-6 mm., density increased. Renal arteries considerably thickened, stomach catarrhal, intestines natural, subacute cystitis, uterus somewhat atrophic, ovaries and tubes extremely atrophied.

Cause of death.—Exhaustion of senile general paralysis.

Microscopical examination of spinal cord.—Size fairly normal at all levels, no flattening posteriorly, only slight pia-arachnoid thickening. Slight diffuse atrophy in direct tracts both sides, most noticeable in the upper cervical region. The crossed pyramidal degeneration is apparent to the naked eye in the lumbosacral region, but apparently diminishes as the cord is examined upwards. The exogenous fibres in the lumbo-sacral region are all markedly affected, and there is atrophy of the plexus around Clarke's column cells. The posterior roots are also sclerosed, and partially denuded of fibres in this region. In the dorso-lumbar region there is considerable atrophy, but the short, fine fibres are less affected. In the mid-dorsal there is very little root-fibre degeneration. In the upper dorsal there is slight degeneration of posterior roots, and cornu radicular one.

Copy of entries in Barming Heath case-book respecting G. H. G: Date of admission.—April 12, 1897. Age and sex.—61 years, male. Friend.—E. E. G. (wife), 39, H. Road.

Medical certificate (W. E. Boulter, April 10, 1897).—His speech is uncertain and hesitating, and he is generally tremulous. He says he has only been out of sorts a short time, is quite cheerful, and says he can still do his work all right, but people won't take it when he has done it. (2) His wife, E. G., 39, H. Road, says he has been very strange for the past eighteen months, has delusions that he is going to die at once, lays himself out in bed and calls all his children to him. He is much upset by work being refused that he thinks he has done properly.

On admission.—Mind a blank. Has no idea of time or place. Has no knowledge of where he is now, or where he has come from. Is happy and light-hearted, laughs stupidly like a drunken man, and says he feels as happy as a dog. Physically well developed,

well nourished. Lungs healthy. Heart irregular, aortic regurgitant murmur. Is very ataxic. Pupils irregular and do not respond to light. Speech thick and mumbling, will commence a sentence all right, then slur over half a dozen words, and finish off correctly. Knee-jerks absent, free from bruises.

April 27.—No improvement, marked signs of general paralysis.

May 14.—Advanced in general paralysis, much weaker.

June 10.—Very weak and helpless, dirty.

August 20.—Patient had a severe convulsive attack to-day.

November 20.—Patient has picked up again, but very tottery.

February 7, 1898.—He is getting much weaker, speech very bad.

March 8.—Very weak, advanced in general paralysis

April 8.—Very weak and uncertain on his legs. Pupils widely dilated. General paralysis well marked and advancing.

September 5.—Rapidly worse, hardly able to move. Very restless at night, generally sleeps in padded room.

December 8.—Unable to move or help himself, destructive. June 27, 1899.—Very feeble and utterly helpless, no mind.

July 26.—Sank and died this morning at 6.15 a.m. in the presence of Attendant J. Brooker, the probable cause of death being general paralysis of the insane. One bedsore on right shoulder, one in the middle of the back, and a slight one over sacrum. Notice of death sent to Coroner this day, of which the following is a copy: G. H. G., male, 63 years, married, wood sawyer, admitted from 39, H. Road, died at 6.15 a.m., July 26, 1899, of general paralysis of insane (not ascertained by postmortem examination) in the presence of Attendant James Brooker, the duration of the disease being about three and a half years. Bed sore on shoulder and middle of back, no mechanical restraint. (Signed) F. Pritchard Davies, M.D., Medical Officer; Thomas W. Dadd, Clerk (Dated July 26, 1899).

A post-mortem examination was refused (F. Pritchard Davies, M.D., Superintendent).

- Case 69.—Conjugal general paralysis in husband and wife. Definite signs of syphilis in the wife.
- E. C. R., aged 53, married; occupation, furniture dealer. Admitted to Claybury, September, 1896, with delusions and auditory hallucinations; he threatened to murder his wife; there is no history of insanity or intemperance, he was married twenty years

ago, and has one child. Exciting cause attributed to failure in business and family troubles.

Condition on admission.—There is well-marked leucoplacia of tongue, indurated glands in the groin, but no evidence of a scar on the penis. He is in poor bodily condition, the knee-jerks are obtained with difficulty, but no ataxy noted, the pupils are said to be equal, and to react to light and accommodation.

Mental condition.—He is talkative and incoherent, he complains of his wife's actions, and states that he wished to kill her and the boy. At times he has religious exaltation, and wants to die. He talks of his mother possessing a large property, and he is continually making large profits out of the exchange and sale of furniture. His knowledge of time and place is most imperfect. Occasionally he is noisy, excitable and difficult to restrain. Diagnosis, mania of general paralysis.

His general health improved in the asylum, and the symptoms of acute mania gradually subsided. About a year later a growth was found in the left half of the tongue which was called epithelioma; one half of the tongue and the sub-maxillary glands were removed. There was no recurrence of the growth. As no microscopical examination of this was made, it is open to doubt whether this was epithelioma; in fact, the history of leucoplacia, the syphilitic eruption and the syphilitic eruption on the wife, to be afterwards described, make it probable that it was a syphilitic gumma. The symptoms of general paralysis became more marked, tremor of the facial muscles, slurred speech, pupils inactive to light, and occasional epileptiform seizures with mental exaltation, firmly established the diagnosis. On October 12, 1898, he had an apoplectiform seizure followed by paresis of the left arm and leg. accompanied by pyrexia, 103° F. This is of interest in connection with the atrophy of the right hemisphere found post mortem. On November 13, 1899, he again had a seizure affecting the left side. It was noted that his speech was never much affected; in fact, the attendant says that his speech has never been any worse than one would expect in a man who had lost half his tongue. The right knee-jerk just present, the left markedly exaggerated, but no ankle clonus. Right and left triceps jerks exaggerated, all super-His mental and bodily condition ficial reflexes increased. progressively deteriorated, and he died on December 18, 1899.

Post-mortem examination showed the following conditions:— Enlargement of cervical and inguinal glands, but no other signs of syphilis, no evidence of recurrence of growth in mouth. Brain.— Adhesions of dura mater to skull, pia-arachnoid thickening, which gives rise to erosions on stripping, marked wasting of the convolutions in the frontal region, and also of those along the vertex of the hemispheres adjacent to the superior longitudinal sinus. The right hemisphere weighs 90 grammes less than the left, the cortex is diminished, especially of the right hemisphere, and the striæ indistinct. The ventricles, both lateral and fourth, dilated and very granular. Weight of right hemisphere, 475 grammes, weight of left hemisphere, 565 grammes. Atheroma of aorta and coronary arteries, slight atheroma of cerebral arteries about base.

E. R., aged 37, housewife, admitted to Cane Hill Asylum, October 13, 1897, died September 6, 1898. Mental disorder, dementia, with general paralysis, certified cause of death general paralysis of the insane.

On admission the notes state that this patient was a fairly well nourished woman. She was suffering with a syphilitic, scaly eruption on the face and legs, and ptosis of the left eyelid, and had a vacant, emotionless expression. The pupils were unequal, right larger than the left, both inactive to light. Superficial and deep reflexes were increased, and the speech was hesitant, slurred, and indistinct, with tremor of the tongue and face muscles. Mentally she was dull and slow in thinking and answering questions. Her memory and intelligence were much impaired; she had delusions, like her husband, about furniture, for she believed the ward furniture was all hers, and that she could exchange or sell it. The dementia progressed, and on August 25, 1898, she had an attack of left-sided epileptiform convulsions, which lasted for a few days; the condition became worse, and she died from exhaustion on September 6.

Post mortem.—At the autopsy the dura mater was found adherent to the calvarium. The pia-arachnoid membrane thickened and opaque, adherent to the convolutions, which were atrophied and left erosions on stripping. The notes state there is considerable softening in the left hemisphere, chiefly in the frontal and parietal lobes, and an appearance of red softening. (No note is made of the condition of the veins opening into the longitudinal sinus, but it is probable that venous obstruction or thrombosis was the cause, and there is no doubt that the left-sided epileptiform convulsions, from which she had suffered just prior to death, were associated with and due to this condition). The right hemisphere weighed 18½ ozs., the left 21 ozs. No doubt an acute destructive process accounted for the marked loss of weight of the right hemisphere. The condition of the ependyma of the ventricles is not noted, but the lateral ventricles are said to be somewhat dilated.

GROUP 7.—Ataxy with Non-Progressive (? Alcoholic) Dementia.

Case 70.—Ataxy, alcoholism, syphilis, neuropathic family history, delusions of persecution and hallucinations, probably the result of alcoholism and heredity, dementia, which combined with the physical signs led to diagnosis of tabetic general paralysis. Mental symptoms greatly improved, also physical.

T. N., aged 39, admitted to Claybury, August, 1896, formerly a soldier, then commercial traveller, then kept a coffee house. Married, four children, two died a fortnight before birth, other two at birth, full-time. Lived a very dissolute life, given to drunkenness and great sexual excesses, acknowledges syphilis contracted at Aldershot, 1883, well marked scar, enlarged glands, secondary symptoms (treated twelve months), followed two or three years later by loss of sight in right eye. His wife states that he had marked satyriasis and had been unable to attend to his business, thrown about his money, slept badly, rambling round the house at night, and for days had taken nothing but beer.

Physical condition.—Tongue, clean tremulous; palate high; right eye blind, left good sight, pupils Argyll-Robertson; hearing good; deep reflexes lost; gait ataxic; fine tremor of hands; marked anæsthesia of legs, mostly on right side. Impaired sensibility of hands and face, "padded foot," girdle pains, has had gastric crises, and alcoholic gastritis.

Mental condition.—Great loss of memory, especially for recent events. Restless, and of dirty habits, and full of delusions. A little later, March, 1897, he is much distressed in his mind by fixed delusions of persecution. "His execution has been ordered, every hour is his last, so that he lives in continual dread that they are going to fetch him away to hang him."

July, 1898.—He is in good bodily health, but there is a recurrence of persecutory delusions in another form. "Lions and tigers are after him to devour him, and he begs for protection against them," causing him to be noisy and excited.

February, 1899.—Patient attacked by dysentery, from which he recovered. A later note states that he had swallowed stones with suicidal intent.

Health deteriorated, shows signs of tabes of a mixed type, anæsthesia and analgesia of both extremities and trunk, with thermal loss and complete loss of muscular sense—slight ptosis and paralysis of external rectus of both eyes—Romberg sign present, Argyll-Robertson pupils, plantar reflexes almost absent, abdominal brisk, knee-jerks absent.

Mental condition varies from time to time, sometimes much more lost, deluded, and incoherent than at others.

November, 1900.—His physical and mental condition had improved considerably. The memory is still bad, especially for recent events, but he has now no hallucinations or delusions and can talk in a fairly coherent manner and play a good game of draughts. He has also some knowledge of chess. There is much less ataxy and he does not sway when the eyes are shut. The anæsthesia and analgesia are much less and limited to patches on the lower extremities.

August 6, 1900.—Patient is quiet, has absence of all the deep reflexes, some hypotonus, no marked ataxy, no tremor in hands, can undress and dress himself, standing on one foot to put the other through the trouser leg, and able to put on his trousers himself, standing, so that there is very little unsteadiness of position. He can feel light tactile impressions correctly all over the body with the exception of a patch about the size of a crown piece below and internal to the left nipple, where he several times did not respond. Pricked with a pin even sharply, he says that it feels like the point of a lead pencil. When shown that it was a needle he was much surprised. Tested with test-tubes of hot and iced water, there was considerable delay in responding to the hot water, but he always said it was hot. Tested with ice water, he responded quicker and said it was hot and burnt him. He never once said it was cold. In fact, given to him with his eyes open to grasp in his hand, he said it burnt him, and he could not be induced to take it again. There is no loss of joint sensation and no loss of sense of position. There is well-marked, old optic atrophy of the right eye, some impairment of the sense of smell, none of taste. His mental condition indicates considerable dementia, he thinks that it is April. he does not know how long he has been here. He can give a pretty clear account of his previous life, which must have been a dissolute one.

- Case 71.—Tabes, osteo-arthropathy, drink, syphilitic history, hemiplegic attack, mania, dementia, mental improvement, pronounced signs of tabes. (Reported by W. F. Forshaw, M.R.C.S., L.R.C.P.)
- C. W., admitted to Claybury Asylum, July, 1900. Age on admission, 41. Occupation, ironer. Married, but has no children; has had no miscarriages. Shortly after admission was diagnosed as post-hemiplegic mania.

Resume of patient's history previous to admission (her own account of it).—Had her left arm "pulled out when a girl." Has always been subject to ulcerated throats. Hair used to come out in combfuls. Barmaid for five years, addicted to drink (beer, whisky). Slipped down in street and fractured right tibia. "She was only aware that the leg was broken when she looked down at it and saw the bone sticking up." It was therefore painless, and indicated tabetic bone lesion. Had a seizure in street one year previous to admission, became unconscious and paralysed on right side after it. Attended Brompton for phthisis, and was advised to go abroad.

Mental state on admission (July, 1900).—She was very excitable and restless, wished she was dead, said "she was tired of life." She was dangerous to others, and threatened to kill the workhouse officials because they had been making irritating charges against her, and because she had been starved and illtreated. She soon, however, became depressed and despondent, and could not or would not give a rational account of her past life.

Physical condition on admission.—She was unable to walk, and had a right-sided hemiplegia. Her knee-jerks were not obtainable, and her pupils did not react to light or accommodation. She had no physical disease of the lungs or heart. Her right knee was much enlarged and leg everted; the patella was on the outer side of the joint, her foot was at a right angle outwards due to the ill-setting of an old fracture of the tibia. She was generally impaired in health and bodily condition.

A fortnight after admission her temperature suddenly rose to 103.8°, and she was unable to speak. No physical signs of illness found in any of the viscera; three days after this sudden onset of fever, she began to have seizures chiefly affecting the right side, numbering thirty-one in all. Ten days after cessation of seizures she was well again as regarded her speech, &c. She gradually improved physically, and two months later she was able to walk. She became quieter mentally, though had frequent maniacal outbreaks, and assisted in the ward work, and has remained in this state up to the present time, which will now be described in detail.

Present condition (March, 1902): Mental.—She is quiet and orderly, answers questions directly and correctly, has a good memory for remote and recent events, and is very anxious to get out of bed to help with the work. Physical.—There are no signs of hemiplegia now; her right leg is practically a "flail leg," it does not touch the ground when she is standing straight, quite two

inches shorter than the other. This shortening is at the knee joint and in the leg itself. The right knee-joint is swollen and full of fluid (fluctuation to be had easily, also the patella tap). is great disorganisation, the patella is on the outside of the joint, there is a loose body in the joint just above the patella, which feels like a piece of bone probably broken off from the external condyle; crepitus is to be had easily by rubbing it against the patella; the internal condyle of the femur is very much expanded, especially antero-posteriorly, the joint is much wider than the corresponding one. This swelling came on suddenly, and reached its present size in three days; it is painless, and the skin is not abnormally heated. Her foot is more everted than it was on admission owing to the condition of the knee, and her leg moves abnormally in extension, flexion and rotation. Other joints of body appear normal. Her pupils and knee-jerks remain as on admission. She had an attack of acute shooting pains through the right side of her abdomen three weeks ago, "like knives running into me," and vomited in consequence. The sensation of her legs is very much changed. This change is most marked on the left leg, especially in the region supplied by the fifth lumbar root; she was anæsthetic to light touch over this region, could not discriminate between prick or touch, or hot or cold. Something similar on right leg, but not so marked; could distinguish between hot and cold. Sensations very faulty generally over both legs. There is no analgesia of thorax, but there is a well-defined belt of trunk light tactile anæsthesia extending from the lower border of the third rib to the lower border of the sixth rib, both Heart and lungs appear normal. She has front and back. had difficulty with her urine lately, and three days ago she had to be catheterised, 45 ozs. drawn off. Since then she has passed urine regularly, averaging between 60 and 70 ozs. per diem. She has a median scar on palate, it looks like an old cleft-palate operation. She speaks with a lisp.

A week later, April 4, 1902.—Patient has been in bed for the last ten days. The swelling of the right knee is much less marked; there is no heat or redness. General improvement since.

Interesting Hospital Cases.

Case 72.—Macropsy and micropsy, transitory aphasia and right hemiplegia, doubtful diagnosis of general paralysis or syphilitic brain disease.

H. B., aged 43. Came to Charing Cross Hospital for weakness in the legs. History of syphilis from the doctor. Pupils of

medium size, sluggish reaction to light. Knee-jerks present both sides. After leaving the hospital he was affected with a transitory aphasia and a right hemiplegia. Rigidity in his right arm and leg set in and persisted. He did not lose consciousness, but he suffered for some time with a headache; later on he was affected in the following way: whilst sitting at home he complained to his wife that the picture frames were empty, his trousers were moving up his legs, and that the handkerchiefs on the table were moving towards him. He could not sleep, and said the bed was being pulled away from him, and the sheets were being plaited. was the first time his wife noticed anything wrong mentally. On April 28, on taking a walk with his wife he suddenly became rigid and drawn to his right side, nearly causing him to fall. Patient says that two years ago he had tingling sensations in his right foot, which he afterwards felt in his left foot. For the last six months he has had some difficulty in getting from his bed to the floor, having lost sensation in his feet. He has lost three stone in weight during the last year. There is nothing else noteworthy in his past personal history, except for the fact that for the past fifteen months, according to his wife, patient has dragged his right leg in walking.

Present condition.—Patient is pale, has a drowsy apathetic expression. He answers questions slowly, and although he is fairly accurate in his answers, it appears to cause him trouble in comprehending what is said, and in recollecting in order to answer. Both pupils equal, react sluggishly to light. Discs: nothing definitely abnormal discovered by Mr. Collins. Patient says his eyesight is becoming worse, and he complains that things appear to move, and that objects sometimes appear too large, and sometimes too small.

Case 73.—One of a family of six suffering with Friedreich's disease.

Pains, but no loss or diminution of cutaneous sensibility.

Marked ataxy.

A. W., aged 37, admitted to St. Pancras Infirmary, October 19, 1900. She is the eldest of six members of her family, all affected with Friedreich's disease. She was an out-patient under Dr. Ormerod for twenty-one years.

Family history.—On the father's side there is a history of fits, on the mother's side, grandfather paralysed. The illness began when she was 15 with jerky movements which the doctor thought was chorea. She was able to walk up to the age of 31, since then

her speech became affected, her back more curved, and the muscular weakness more pronounced. She is very feeble, being hardly able to raise the legs from the bed or to sit up, but able to use her hands and knit, but she would be unable to do this in the dark.

Present state.—Patient has a rather weak, fatuous, but mobile expression, there is more paresis on the right side of the face than on the left, the tongue is protruded slightly to the right. Her speech is thick, somewhat indistinct, slurred, lisping, and occasionally stumbling, but she is able to pronounce all the letters, and there does not appear to be any more difficulty with one word more than another. There is no tremor in the lips or tongue, and I could detect no nystagmus, although there were irregular, oscillating movements of the neck. The grasp is very feeble, and there is a difficulty and a slowness in unclasping the fingers, so that the hand seems to stick. She had suffered much with shooting pains, and they cause her legs to jump a great deal. There is marked ataxy and loss of sense of position in the hands, but she knows what I am doing when I straighten or bend the fingers, showing that she can appreciate joint sensation. In the lower limbs there is marked talipes equino varus, the muscles are somewhat wasted, the deep reflexes lost, the superficial plantars exaggerated. There is but moderate hypotonus. Sensibility to pain and touch good and correct in localisation, but the response is slow; but this may be only due to slow mental reaction, which is very marked when you converse with her. The epigastric reflexes on the left side lost, but slight crossed reflex of the right; right side absent, no crossed reflex. There is no anæsthesia or analgesia anywhere in the trunk, there is very marked scoliosis of the spine, which is due to a dorso-lateral curvature to the right. There is great weakness of the trunk muscles and of the erectores spinæ. She is quite clean in her habits, careful and intelligent, and in good bodily health, save the paralysis.

Case 74.—Examples of optic atrophy affecting one child, facial paralysis another, and several others suffering with fits. No signs of syphilis on the body, but a certain history of syphilitic infection of the mother.

This family history is of interest, because, had I not been able to obtain full particulars from the practitioner, I could not have found either from the mother or the examination of the children, that syphilis was the cause of the optic atrophy in the child who was brought to see me on account of blindness.

F. C., aged 11, was brought to me by Dr. Atkin suffering with blindness of both eyes since he was 7 years of age. The right eye became first affected, and then the left. He attended Moorfields for four years without benefit for optic atrophy, cycloplegia, and iridoplegia: on the card it is put, (?) Syphilis congenital. There are no signs of congenital syphilis now on the body, although Dr. Atkin informs me that he treated the boy when an infant for snuffles and a rash. Up to nine months ago he could see to play with other children, but he has gradually become quite blind, and has been sent to a blind school. There is slight evidence of facial paresis of right side, and the tongue protrudes towards the right. Grasp is good in both hands, and there is no loss of power. All deep reflexes somewhat exaggerated. Mentally he is intelligent, quick witted, and comprehends well.

History of maternity.—Mother married eighteen years, six children, and one miscarriage. Such a history with no signs of syphilis on the bodies of the children would allow the statement, no history of syphilis; in fact, some authorities would cite this case as one, proving that optic atrophy could arise independently of syphilis; perhaps it can, but this and many other cases that are cited do not prove it.

Miscarriage, seven months; (1) Boy, died in a fit, aged 1 year and 9 months; (2) Girl, now healthy, aged 15; (3) Girl, now healthy, aged 13; (4) Boy, the patient, aged 11, optic atrophy; (5) Boy, aged 9, left facial paralysis at six months, commencing optic atrophy; (6) Boy, aged 6, fits until five years old.

Dr. Atkins informed me that the mother, three months after marriage, suffered with sore throat, ulceration of the womb, and a characteristic rash for which he treated her.

MORBID ANATOMY AND PATHOLOGY.

Introduction.

We have already seen that the clinical cases show all grades of tabes with slight mental symptoms and pronounced cord symptoms to those of very pronounced mental symptoms and slight cord symptoms. Consequently there must be a number of intermediate cases between the two extremes, and it would be extremely difficult to decide whether they should be called tabes or general paralysis, and the invention of the term tabo-paralysis is an indication of this clinical difficulty. In like manner, and as a matter of expediency (especially among private patients) such cases are at first called locomotor ataxy. There can be no hard and fast clinical line between the two diseases; etiologically I have shown that they are practically identical; are they pathologically so? This question can be studied best by an examination of a sufficient number of these intermediate Nageotte asserts that he found changes in the posterior columns in two-thirds of all forms of cases of general paralysis, and he looks upon the diseases as pathologically identical. Fürstner, who has made a most careful study of this subject, does not agree with Nageotte that the spinal cord exhibits typical tabic lesions in anything like so large a proportion. He concludes that the spinal cord is invariably affected in some part of its structure in general paralysis; he states that there certainly occur cases where the spinal lesion is first; also a series of clinical symptoms corresponding with the anatomical findings.

Dr. Watson finds posterior column degeneration of exogenous systems in five out of eight cases of juvenile general paralysis.

If it be admitted that syphilis is the most important (if not essential) cause of both these two diseases, and very strong proofs now exist of the truth of this doctrine, which is daily becoming more widely accepted, then, just as we find that alcohol, lead, diseased maize, ergot, and other

poisons may produce in one individual a morbid process in the brain, cord or peripheral nerves, while the disease process attacking the nervous system is essentially the same, so I will endeavour to show that the effect of the syphilitic poison on the nervous system may in one person produce a degeneration of the spinal afferent protoneurons, in another of the optic nerves, or the cerebral cortex, and, according to the structure affected primarily, the disease is classified as spinal tabes, optic tabes, tabo-paralysis or general paralysis.

Here I will also take the opportunity of remarking that some of the most rapidly progressive cases of paralytic dementia have been those in which, simultaneously with the brain affection, there has been cord affection also. A case of juvenile paralysis, published in the first volume of the Archives of Neurology, p. 278, died within four months of the onset of the disease; several other cases (68, 69) likewise show a rapid progress. The onset of the cerebral symptoms generally, but not necessarily, leads to a cessation of the morbid process affecting the spinal cord and vice versa; it may then be asked, is the disease one affecting the vital energy of the neurons of the whole nervous system; and in the struggle for existence, do those die upon which the greatest amount of stress falls, aided by contributory precarious vascular supply, or some devitalising condition, especially hereditary defective durability? How can, however, the environment affect the decay of structure, unless there is a deficiency in the nutritive properties of the environment of the neurons?

We might assume, hypothetically, that there is some biochemical defect or subminimal deficiency in the blood, the lymph, or the cerebro-spinal fluid, by which nervous metabolism may be rendered incomplete. Those nerve structures with the highest vitality, in a struggle for existence, would be able thus to extract a sufficiency of the necessary complex phosphorised materials for maintaining physiological equilibrium and for the formation of protagon; whereas, if there is a total insufficiency, those with less vis propria would first waste and undergo atrophy. A vicious circle is very apt to

be established when structures presiding over important functions of the body are diseased, and then secondary complications arise and may be mistaken for the initial cause. I look upon these diseases as primarily a premature process of decay; the term "abiotrophy" recently introduced by Sir William Gowers (Lancet, May, 1902) expresses aptly in one word what has been said above, and previously expressed in my Croonian Lectures.

The disease, whether it is elective (affecting only some particular system of afferent fibres in the spinal cord or the optic nerves), or whether it affects only the cerebral cortex, is a veritable tabes or wasting. This wasting, however, may be general and affect the whole central and peripheral nervous systems. In many cases of tabo-paralysis the cord is so wasted that in a big muscular man, e.g., Br—, 54, and Case 31, the cord was not so large as that of a two-year-old child. Both gray and white matter were atrophied, and without any proportional overgrowth of glia or thickening of membranes. The process as thus seen appears to be a biochemical failure on the part of the neurons to maintain physiological metabolic equilibrium.

The paroxysmal attacks of pains and crises, maniacal and epileptiform seizures, are clinical expressions of an irritant action, and suggest the formation or accumulation in the blood or lymph of some toxin which has a local action, unless we assume that the decay of the neurons (terminating in death) is accompanied by increased irritability. In the discussion of the changes in the brain, we shall see that there is much more reason to suspect the existence of an irritant toxin which produces acute destruction of the neurons and formative proliferation in the vessel walls and perivascular lymphathic sheaths, also active glia proliferation -all being the results of a conspiracy of morphological and biochemical factors. In the case of the spinal cord, the thickening of membranes and the changes in vessel walls are inconstant, and can in no way account for the elective destruction of fibres in the posterior columns; although as I have previously said, initial affection of certain segments of the spinal cord, as shown by the symptoms—especially the cutaneous sensory disturbances—may be explained by a precarious vascular supply in these regions; but then, this is not the essential factor, only the contributory one. Morbid anatomy and clinical observation show that there is both systemic and segmental election in the pathological process.

Methods of Observation.

The tissues were obtained in a fresh condition and hardened in a manner suitable for staining by Nissl, Pal, Weigert, Marchi, and Marchi-Pal methods. Various other methods were employed (when necessary), such as the Heidenhain, Gudden carmine, and Bolton's iron alum; the sections were either cut in paraffin by the large Cambridge rocking microtome for the Nissl and Heidenhain methods and always of uniform thickness; or, for the other methods, cut in celloidin after hardening in Müller or Formol-Müller. A systematic examination was generally made of the spinal cord and roots at every level, together with the cauda equina. A number of the posterior spinal ganglia were also examined. Sections of the brain cortex in various situations, usually of Broca, first frontal, ascending frontal and ascending parietal, prefrontal, occipital, temporal and angular were made in a number of cases by Nissl method as well as by one of the before-mentioned methods to demonstrate the fibres. medulla and, in a few instances, the pons and internal capsule were also examined; likewise the optic nerves and in some instances the retina, the peripheral nerves of the skin and muscles in a few instances, and in a considerable number of cases, the ulnar, median and sciatic nerves. I do not lay claim to have examined all these tissues in so systematic a manner as I have the cord and cerebral cortex; the observations have been made rather with a view of establishing the fact that the disease is one primarily of the central nervous system, and that the peripheral structures are affected later in the disease.

The spinal cord lesions of tabes and tabo-paralysis as regards the affection of the posterior roots and posterior columns are, as a rule, identical. In both diseases there is the same system of exogenous fibres affected in the same

situations in the spinal cord. The morbid process elects first certain groups of fibres and spares others, but eventually, in advanced cases, destroys nearly all the exogenous fibres. Many symptoms and signs, and especially the distribution of anæsthesia in the cases of tabes and tabo-paralysis (in which the cutaneous sensibility could be ascertained), indicated that certain segmental regions of the spinal cord are earliest affected; and systematic microscopic examination of the spinal roots and of the spinal segments showed that certain regions are more affected than others—viz., lower lumbar and sacral, mid, upper dorsal and lowest cervi-With few exceptions all the spinal cords were obtained from well-defined tabo-paralytic cases; but in some of those dying within the last year, I have systematically examined the patients for cutaneous anæsthesia, and made charts of the same, and correlated the results (Cases 31 and 46) with the microscopic investigation. Charts of the spinal degeneration at various levels have been made by means of Edinger's projection apparatus, so that the distribution of the degeneration can be studied at a glance.

Posterior roots.—Sections of the cauda equina in most of the cases were made by tying all the roots together, and embedding in celloidin. Microscopic examination almost invariably showed (whether the case was early or late) that degeneration or disappearance of fibres had taken place, relatively proportional to the atrophy of the exogenous system, in the lumbo-sacral region of the cord. Sections, longitudinal and transverse, which had been stained by Marchi fluid very seldom showed any degenerated black fibres, and they presented none of the appearances of Wallerian degeneration of nerves. When stained by Pal or Weigert, some fibres which stained blue might be normal in appearance, others appeared very much attenuated, as if the myelin sheath had atrophied; moreover, they stained a fainter blue owing to the thinning of the myelin. The bundles of posterior roots, which are normally considerably larger than the anterior roots, were much smaller and diminished in size, in proportion to the The interstitial tissue was sometimes inoutfall of fibres. creased, although there was not always a proliferation; the

vessels were often seen engorged with blood, but not more so than those of the undegenerated anterior roots. The walls of the arteries and arterioles were more often normal than not; when thickened, it was generally in a subject over 50, and the thickening was not limited to the posterior roots, but affected also the arteries of the comparatively healthy anterior roots. I do not remember seeing one which presented the typical character of recent syphilitic arteritis, though it is not uncommon to find a condition of arteriosclerosis, which might, of course, be indirectly of syphilitic origin.

Teased preparations of the posterior roots were made and stained with Marchi, with logwood and ammonium picrate, and with various other stains. The appearance presented reminded me of the condition found in a nerve after section, when all the products of degeneration have been absorbed. Empty neurilemmal sheaths with proliferated nuclei, vessels and connective tissue are the only structures found, as a rule, in the roots which have undergone degenerative atrophy. Some fibres still possessing a myelin sheath may be found amidst this tissue, if the root-fibres are not completely destroyed (vide fig. 38). The myelin does not show black globules like a degenerated nerve-fibre, but occasionally a fine black dust scattered through its substance, as if a slow molecular Wallerian change was taking place; or the myelin might be simply diminished in amount, and attenuated to various degrees in some places, while of fair thickness in others. Where the myelin is diminished, several nuclei of the neurilemmal sheath could be seen, as if the atrophy of the myelin had been followed by, or associated with, nuclear proliferation. Phagocytes containing blackened myelin were seldom seen, except in some few cases of rapid tabo-paralysis.

The roots in a case of ataxic paraplegia, where there was marked degeneration of all the long tracts of the spinal cord, presented quite a different appearance; for the myelin sheath was of normal thickness, showed nodes of Ranvier, and a very little interstitial tissue, and only the normal number of nuclei in the neurilemma. Some of the fibres

showed an appearance like Wallerian degeneration, but the majority showed no change; the morbid process was therefore intraspinal, whereas the degeneration of the sensory posterior spinal neurons of tabes is intradural, for the degen-



Fig. 38.

Two fibres from posterior root, eleventh dorsal, Case 49. Magnification, 400.

erative atrophy extends back as far as the spinal ganglion. My results, therefore, conform in great measure to the observations of Philippe upon this point. Before dealing more in detail with the distribution of the intraspinal degen-

eration of the exogenous system of the posterior columns, and the additional degeneration of other systems which may occur, we shall consider the changes which may be observed in the spinal ganglion itself.

Spinal ganglia.—The attractive theory of Marie based upon the neuron doctrine that the degeneration is due to a nutritional change in the posterior spinal ganglion cells is one which explains many facts, but the argument which is advanced against it is this: if it be so, why are not nutritional changes manifested histochemically by the Nissl method? Some authorities, Wollenberg, Ströbe, and others, have described changes in the posterior spinal ganglion cells; on the other hand, numerous observers have asserted that the changes which have been found were insufficient to account for the changes in the roots and cord. The examination of a large number of sections of posterior spinal ganglia, from the majority of the fatal cases I have recorded, has not satisfied me that the changes which I observed were sufficient to account for the disease. The changes in the cells were indeed insignificant as compared with the degenerative atrophy of the fibres emerging from the ganglion. In many instances, some few of the cells were shrunken, the nucleus eccentric and even the capsules empty, as if there had been a complete atrophic decay; but the majority appeared fairly normal, both the large, medium, and small sized. Frequently excess of pigment was seen, but the same might be found in the cells from any old person. Sometimes the great majority of cells of a ganglion stained blue by Pal, and by examination with an oil immersion, it was found that the protoplasm was beset throughout with fine dust like blue particles. The same may be seen in early fatty degeneration of muscle when stained by this method, and it may be that the protoplasm of the cells have undergone a recent fatty degenerative change. with Marchi the same cells for the same reason may appear The process to my mind is acute, and may well be due to complications occurring in the tabo-paralytic towards the end of life.

Sections of posterior roots in animals did not, I find,

give rise to any degeneration of the spinal ganglion cells. Lenhossek at first thought there was a change, but further observations caused him to renounce this opinion. If neurilemmal cells play an important part in tabes, why are posterior roots invariably degenerated back to the ganglion?

Peripheral nerves—white rami, gray rami, sympathetic.— In a number of cases the peripheral nerves were examined, median, ulnar, and sciatic, sometimes the nerves of the skin, sometimes the nerves entering the muscles, e.g., vastus internus. The white rami, gray rami, and sympathetic were also examined in a few cases, but a more systematic examination is now being carried on by Dr. Goldschmidt.

It may be stated generally that the peripheral cerebrospinal nerves like the spinal cord of advanced cases of tabo-paralysis were smaller in trans-section than normal, and without any microscopic examination it would be said that they were apparently atrophied.

A section longitudinally through the spinal ganglion with a portion of the roots and issuing nerve attached stained by Weigert method, and examined microscopically, leaves no doubt in the mind of the observer that the disease is essentially one of the intradural portion of the spinal afferent neuron. He will observe the anterior root, consisting of normal fibres, lying by the side of the degenerated and completely atrophied posterior root (fig. 39), and he will conclude that no mechanical process of strangulation at the point of exit from the dural sheath will explain this fact. At the proximal end of the ganglion he will see very few fibres, and these much attenuated; whereas, at the distal end he will observe the fibres emerging of normal appearance, and as well stained as the fibres of the anterior roots. Again, he will consider that it is impossible for a vascular change within the ganglion to account for the distal portions of the T-shaped processes of the cells to have escaped.

I have, however, noticed in longitudinal sections of the posterior spinal ganglion with a long attachment of the ventral and dorsal roots, that the myelin sheath of fibres, which still possess the property of staining blue by the Pal

or Weigert staining, becomes sometimes more attenuated and fainter as one proceeds away from the ganglion towards the cord. Again, one may find the peripheral fibres proceeding from the ganglion quite healthy in appearance (as regards myelin staining) in an advanced case of tabes, and yet the remote sensory fibres degenerated. Dr. Anderson has kindly allowed me to quote some valuable observations which he has made upon the development of the myelin sheath in the posterior roots and peripheral nerves bearing upon this point, to be described later.



Fig. 39.

Photomicrograph of a transverse section of the posterior root (third lumbar). The small, dark round bundle of fibres is the undegenerated anterior root, the large sclerosed root is the posterior. Section stained by Weigert hæmatoxylin. Magnification, 20.

Examination of the Peripheral Nerves.

Transverse and longitudinal sections in some advanced cases showed changes, but in no degree sufficient to account for the symptoms, or in any way proportional to the atrophy of the posterior roots. The ulnar nerves of Case 31 showed

recent degenerative changes; some of the fasciculi of fibres contained a few black stained fibres by the Marchi method, due, apparently, to Wallerian degeneration; and in some places there seemed to be an excess of interstitial tissue and a diminution of fibres. In Case 49, however, where there was extensive muscular wasting of the small muscles of the hands with reaction of degeneration, and atrophy of the anterior horn cells and anterior roots, there was naked-eye degenerative sclerosis of the median and ulnar nerves. This was quite apparent when the nerves (after hardening in Müller) were cut in transverse sections, and showed a marked atrophy of fibres with substitution fibrosis. sciatic nerve likewise showed a similar change; but there was not the same atrophy of the anterior horn cells, as seen in the cervico-dorsal region; the cells in the lumbo-sacral region, on one side more than the other, showed a process of regressive atrophy; the cells were there, but their processes were broken off, and there was not the same degeneration of the anterior roots. The process was very probably the same, but not so advanced, as in the cervico-dorsal region; still the outlying portions of the neurons had undergone atrophy.

The cause of this degenerative atrophy will be further discussed later; also, considerations will be advanced as to why the central projections of the posterior spinal neurons should be degenerated when the distal remain unaffected; it is generally admitted that the peripheral terminations of the nerves in skin and muscles are more likely to show degenerative atrophy than the portions nearer the cells of origin. My examinations of the skin are not sufficiently numerous, nor do I think the methods usually employed are sufficiently reliable, to make any definite statements with regard to the importance of the changes; yet the examinations I have made were sufficient to convince me that in early cases there was little or no appreciable degeneration, while in the late cases, although there was undoubtedly atrophy and disappearance of fibres, the changes were of far less importance as compared with changes in the posterior roots. This coincides with the obvious segmental root distribution of sensory disturbances observed during life.

The white rami were examined in a few cases in serial section; it was observed that there were some large medullated fibres, which could be traced into the sympathetic trunk, and a large number of small medullated fibres, together with some gray sympathetic fibres.

The Exogenous Systems of the Posterior Columns.

In all the twenty-eight cases examined, the three sets of coarse fibres entering the cornu-radicular zone, and proceeding respectively to the root zone of Charcot, to the cells of Clarke's column, and to form Goll's column, were affected; not always, however, to the same extent, for the relative degree of degeneration of each of these three systems of fibres depends upon the relative degree of degeneration of particular roots. For, although every root in the lumbosacral region, where the morbid process in the great majority of cases commences, contains fibres belonging to each of the three systems, namely, spinal, cerebellar, and cerebral, yet some roots, according to the functions of the structures innervated by them, contain many more cerebral afferent fibres than cerebellar and vice versâ. The appearance of Clarke's column at the level of the second lumbar segment and its disappearance at the second dorsal is an indication of the important relation of this system of neurons to the muscles of the trunk and the muscles used in maintaining the static position.

I have shown 1 experimentally that the very large first sacral posterior root of the monkey possesses a large number of fibres belonging to all three systems, but especially to the cerebral system; this root is distributed to the whole of the sole of the foot and its deep structures; it is, therefore, of great importance in conveying sensory impulses essential for the maintainance of gait and station.

Examination by the Marchi method of the different segments of the cord, after section of this posterior root in the monkey on one side, showed: (1) That a very large number of fibres of this root enter into the formation of the

[&]quot;Die Zuführenden Kleinhirn Bahnen des Rückenmarks bei den Affen." F. W. Mott. Monatschrift fur Psychiatrie, vol. i.

column of Goll, apparently nearly half of the fibres of this tract in the cervical region being degenerated, and the degeneration uniformly distributed over the whole triangle; (2) that a considerable number of fibres enter the root zone of Charcot, in the first sacral segment especially, but also in the segments above and below; (3) that at the third lumbar segment the only degenerated fibres found in the posterior column consist of a band which extends from the mid line back to the periphery, leaving internal to it a small triangle undegenerated, probably tail fibres.

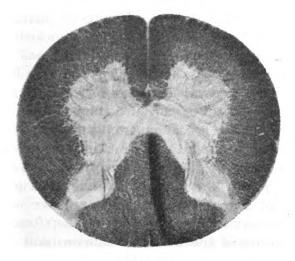


Fig. 40.

Photomicrograph of section (third to fourth lumbar segment) of spinal cord of monkey, after section of first sacral on one side. The black band seen represents the degenerated fibres belonging to the cerebellar and cerebral systems. It will be observed how very extensive this degeneration is. As soon as Clarke's column appears at the first lumbar a large number of these black fibres run forward to end in a plexus around the cells, leaving the fibres of Goll's column as a compact triangle posteriorly.

As soon as Clarke's column begins to appear at the upper part of the second lumbar segment, the anterior half of these degenerated fibres runs forward to end around its cells; and not until about the eleventh dorsal segment do these degenerated fibres cease to be found entering Clarke's column. The degenerated fibres of Goll's column then form a definite posterior internal triangle, which can be followed up to the medulla. This experimental evidence shows what a very important part this root, which is so often affected in tabes, must play in the production of ataxy of gait and station, by the cutting off of guiding sensations to the cerebrum and cerebellum.¹

The padded foot or complete anæsthesia of the sole, with abolition of cutaneous reflex, means, therefore, abolition of the fibres for cerebral and cerebellar impulses, and explains the increase of the ataxy when the sole of the foot is anæsthetised by cold. The ataxy, I am of the opinion, has a decided relationship to the atrophy of the plexus around the cells of Clarke's column, and I have not seen any case in which this was pronounced without marked ataxy, whereas I have seen other examples in which this was not pronounced, although Goll's column was markedly affected. Several cases showed comparatively little cutaneous anæsthesia, and yet there was very marked ataxy.

There is another set of exogenous fibres which, according to Bechterew, convey sensations from the skin; these fibres are small in size and run a very short intramedullary course. In the lumbo-sacral region they occupy at least two-thirds of the zone of entry, or zone of Lissauer, and give origin to numbers of fine collaterals which arborise around the cells of the posterior horn. They do not, therefore, take part in the formation of the posterior column, and it may be presumed that these fibres convey sensory impressions from This is more easy to understand if we accept the hypothesis that the same fibres conduct pressure and pain impressions, but that quality and intensity of stimulus determine the sensation produced. In syringomyelia, however, we have sensory dissociation, touch being perceivable, but heat, cold, and pain not, for the reason that the grey matter is destroyed and the exogenous fibres of the posterior column are intact; it may be presumed then, that the gray matter conducts painful sensations, and the posterior columns conduct tactile; but the segments of gray matter of the posterior horn are united by long and short ascending

¹ Anderson has found that section of the seventh post-thoracic root (corresponding to the first sacral) produces in kittens an atrophy of the cells of Clarke's column, and he confirms the above observations of mine.

and descending association fibres, and their preservation, at any rate for a considerable time, may account for the delay, yet eventual transmission of sensory stimuli, in tabes, to the brain.

The fine fibres of Lissauer's tracts were in a few cases not affected at all. In many cases (eleven out of twenty-eight) when there was a marked affection of the root zone of Charcot, the fine fibres of Lissauer's tract were but slightly affected. In a few instances where it had been possible to investigate the sensory cutaneous disturbances during life, it was found that there was a relationship between the degree and extent of the same, and the degree and extent of distribution of atrophy of Lissauer's tract. Head and Campbell call attention to the great number of small cells in spinal ganglia of the trunk region as compared with the cervical and lumbo-sacral regions. They consider that the small cells subserve the function of pain, but some are no doubt afferent splanchnic neurons.

Several fatal cases were examined in which the sensory disturbances were either absent or comparatively slight, yet the motor incoordination was marked and the previously mentioned three sets of fibres in these cases were atrophied.

Occasionally, as Redlich and others have observed, in early cases terminating fatally acute changes may be found affecting the intramedullary portion of the exogenous neurons, and not the roots. Case 52 was an example of this, where the patient did not long survive the onset of the spinal symptoms, and we find a number of recent degenerated intramedullary fibres in the lumbo-sacral region, limited to definite systems (fig. 41). The coarse internal fibres entering the cornu radicular zone are seen degenerated at all levels of the lumbar and sacral regions; the black degeneration products are neither found in the entering zone of fine fibres of Lissauer's tract, nor in any of the sections of the posterior roots attached to the sections of the cord; the degeneration is therefore intramedullary and selective.

No cutaneous disturbance was observed during life, although there was ataxy; the coarse degenerated fibres belonged to (1) spinal reflex, (2) cerebellar, (3) cerebral

afferent systems, and occupied respectively (1) the root zone, terminating at the base of the posterior horn, (2) the fibres entering Clarke's column, (3) the fibres entering Goll's column.

There was no meningitis which could account for this intramedullary degeneration; moreover, if this were the cause, it should not be selective in sparing the fine fibres of Lissauer's tract. In such a chronic disease as tabes usually is, it is quite probable that a process of degeneration akin to

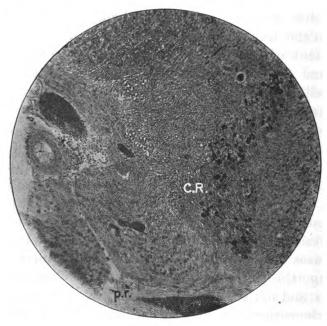


Fig. 41.

Section of spinal cord, first lumbar, Case 52, showing degenerated fibres in the cornu-radicular zone, C.R. The posterior roots are free from degeneration; so is Lissauer's tract.

Wallerian degeneration frequently occurs, the products being absorbed; but it is likely that all degrees of the process of myelin disintegration may take place; in some instances it is slow wasting, due to disintegration exceeding normal integration, and involving a gradual process of atrophy; in other instances, a rapid acute disintegration occurs akin to Wallerian degeneration, and between the two extremes there are probably all grades of destructive change.

The Endogenous Systems of Fibres of the Posterior Columns.

In the nine cases where there were very marked ataxic symptoms, the following results were obtained by microscopical examinations:—

- (1) The descending endogenous system of fibres was markedly affected in six instances, and in three very markedly.
- (2) The ascending endogenous system (cornu-commissural of Westphal) was never completely destroyed throughout the cord, even in the most advanced cases, although in one or two instances, e.g., 49 and another case, notes of which are not recorded, but which is contained in the Table, it was almost absent in some regions.

In cases of endogenous system degeneration, there was invariably a very marked atrophy of the exogenous system. In nearly all the cases which commenced with optic atrophy, eventually terminating in blindness, there was no appreciable affection of the endogenous system; this, however, was not invariably the case, striking exceptions being Cases 28 and There was a decided relationship between the degree of affection of the endogenous systems of the posterior columns and the degree of ataxy, moderate atrophy of the endogenous systems occurring in persons who were well on in the second stage of locomotor ataxy. All those with marked or very marked atrophy were in the advanced bed-ridden paralytic stage, and one or two presented muscular atrophy. All those in the pre-ataxic stage showed no degeneration of the endogenous systems, although there was extensive atrophy of root-fibres and their intramedullary projections in many instances.

Origin of the fibres of the endogenous systems of the posterior columns.—Many observers have shown that transverse lesions of the spinal cord produce descending degeneration of the posterior columns. Dejerine and Théohari point out in their communication that Schultz, Bruns, v. Lenhossek and Obersteiner consider that the comma tract is composed of exogenous fibres; Tooth, Pierre Marie, Gombault, and Philippe and Daxenberger, that it is composed of endogenous fibres. Dufour and Philippe (in his thesis)

think that the comma tract and the dorso-median degeneration in the lumbo-sacral region represent one and the same system of endogenous fibres. Purves Stuart in Brain has recently expressed the same opinion, based upon the examination of the descending degeneration resulting from a crush of the cervical region. Flatau, on the contrary, believes that for the greater part of its extent, the descending degeneration is of radicular origin. Hoche remarks that the long extent of the comma tract does not agree with what is known of the descending branch of the posterior roots; he regards the peripheral degenerated field and the comma tract as two independent systems. Dejerine and Théohari formulate the following conclusions, based upon an analysis of experiments upon animals, and upon the descending degenerations observed in the posterior columns in man, in consequence of pure radicular lesions, and upon a comparison of these degenerations with the descending degenerations observed in two cases of transverse lesions of the cord:—

- (1) The degeneration in the comma tract of Schultze is due in part to the lesion of the descending branches of the posterior roots; the longest fibres of this tract, however, are of endogenous origin.
- (2) The small anterior degenerated zone, which does not extend below the segment subjacent to the transverse lesion, represents short endogenous longitudinal commissural fibres.
- (3) The peripheral bundle of Hoche, dorsal region (septomarginal, Bruce) is continuous with the central oval area of Flechsig and the triangle of Gombault and Philippe, and represents a very long system of longitudinal commissural fibres; it is a system of endogenous fibres.
- (4) The triangle of Gombault and Philippe contains (besides endogenous fibres) a great number of radicular fibres; it is therefore of mixed origin.

My own observations, experimental and otherwise, tend to support these views in great measure, although I am inclined to agree with Dufour, Philippe, and Purves Stuart that the descending fibres of endogenous origin belong to one system.

I consider that these fibres, like the exogenous systems

of fibres, are of long, medium, and short lengths, and serve for the correlation of sensory function of different segments of the spinal cord.

Observation of many cords, in some of which, in the mid and upper dorsal regions, there was a complete atrophy of the root-fibres in cases where during life there was a corresponding loss of cutaneous sensibility of the trunk, showed

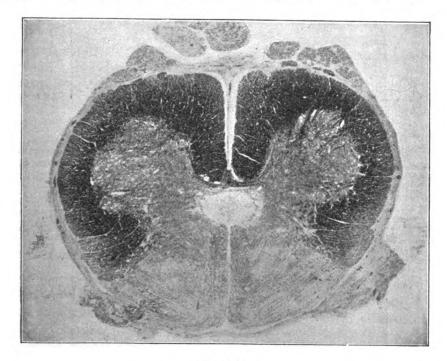


Fig. 42.

Photomicrograph, lumbo-sacral region, of an advanced case of ataxy (taboparalysis). The posterior columns are almost completely denuded of fibres, a few are left in the cornu-commissural tract and the oval area of Flechsig. There is also sclerosis in the crossed pyramidal tracts on both sides. There not much shrinking of the posterior columns, and the meninges are not more thickened posteriorly than anteriorly. The central canal is dilated and filled up with glia tissue.

still a large number of fibres in the situation of the comma tract, and the posterior internal zone extending thence along the dorsal margin of the posterior columns, and continuous at the first lumbar with a small triangle at the side of the median fissure. The fibres in this triangle, as one proceeds to lower levels, are seen to extend up the median fissure, and become continuous with the oval area of Flechsig in the lower lumbar and upper sacral regions, and this again is continuous with the median triangle of Philippe, situated in the lowest sacral segments, *vide* photomicrographs 42, 43, 44.

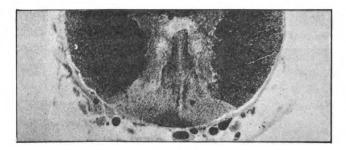


Fig. 43.

Photomicrograph of first lumbar segment (Case 31), showing cornu-commissural zone and posteriorly a small triangle of fibres in the mid-line of endogenous origin.

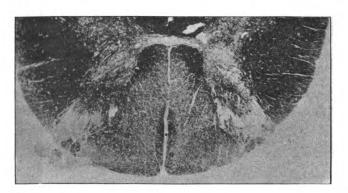


Fig. 44.

Photomicrograph of third lumbar segment (Case 52), showing degeneration of intraspinal portion of exogenous fibres of posterior columns; the ascending and descending endogenous fibres are intact. The continuity of the fibres of the posterior internal zone, the septo-marginal, and the oval area of Flechsig as one tract, is well shown.

In cases of apparently complete degeneration of the rootfibres in the mid-dorsal region, one finds a set of fibres giving off collaterals running on the inside as well as on the outside of the column of Clarke: (a) The inner set of fibres, continuous partly with fibres of the cornu-commissural zone of the same side, partly with fibres of the cornu-commissural zone of the opposite side. (b) The outer set of fibres coming from the posterior horn and running forward to the base of the anterior horn, commingling there with the inner set.

This arrangement is especially well seen in Cases 39 and 46 (vide photomicrographs, p. 157 and Plate IV.).

Cajal has described cells in the middle of the posterior horn which give off fibres entering the posterior columns; these give rise to ascending endogenous systems of fibres in the cornu-commissural tracts, many of the fibres decussating to form the posterior commissure. The cells which give origin to the fibres of the descending system are possibly situated at the junction of the anterior and posterior horns.

In cases of complete root atrophy occurring in the lumbo-sacral, upper, and mid-dorsal regions as exhibited in Cases 39, 40, 45 and 49, numbers of very fine myelinated fibres can be seen in the substantia gelatinosa of the caput cornu posterioris; they can be seen when the fine fibres of Lissauer's tract are completely absent, they form a delicate plexus, and can be observed running horizontally across the base of the caput cornu posterioris. These are probably axis cylinders of the small sensory cells of this region. Again, in such cases of absence of root-fibres, numbers of fine collaterals can be seen in the gray matter opposite the root zone; it is probable that these are derived from the descending endogenous fibres.

In degenerative atrophy affecting the descending endogenous fibres the first to disappear are those in the dorsal region, occupying the comma-shaped tract, its dorsal clubshaped projection and peripheral extension towards the median septum; the next are the fibres of the oval area and posterior triangle of Philippe, with which they are continuous.

Degeneration of the Spinal Cord, other than the Exogenous and Endogenous Systems of the Posterior Columns in Tabo-Paralysis and Tabes.

In advanced cases of tabes sometimes there may be degeneration of the cells of Clarke's column, and as a result thereof, atrophy and sclerosis in the two afferent systems of fibres proceeding from these cells to the cerebellum, form-

ing respectively the ventral and dorsal cerebellar tracts (Case 40).

By far the most frequent and important associated degeneration and subsequent sclerosis is to be found in the pyramidal systems of fibres. In twenty out of twenty-eight asylum cases which I have examined there has been some degeneration in some part of the course of the pyramidal systems. This pyramidal degeneration is evidence of cortical affection, and is due either to chronic atrophic changes in the cortical psycho-motor neurons or acute destructive changes. Sometimes the two are associated.

Examination of the spinal cords of twenty-eight cases of tabo-paralysis has shown me that the affection of the pyramidal systems is in relative order of frequency as follows:— (1) Primary degenerations.—(a) Primary degeneration of both crossed pyramidal tracts, fairly equal on the two sides. (b) Degeneration of both pyramidal tracts, but more marked on one side than the other; this degeneration is slow in progress, not revealed as a rule by the Marchi method, but is shown by those methods which demonstrate sclerosis. Sclerosis is only revealed distinctly in the lumbo-sacral region in a situation corresponding with the position of the crossed pyramidal tract in that region; it can be followed as high as the mid-dorsal region in some cases, but becomes less and less discernible the higher we proceed in the cord. Such may be partly due to intermingling with healthy fibres, but I believe it is mainly due to the fact that this degeneration, which does not involve the direct pyramidal tracts, is occasioned by a slow progressive atrophic process affecting the cortical psycho-motor neurons with the longest axons, therefore those which have their terminal arborisations in the lowest regions of the spinal cord. The pyramidal fibres of the direct tract have a shorter course and consequently are not so remote from their seat of nutrition; as a rule, therefore, are not wasted.

Acute degeneration.—(a) Degeneration of the crossed pyramidal tract on one side, and direct on the other.¹

¹ Starlinger has described two cases in which there was degeneration of the whole pyramidal tract from the cortex. The same was found by Boedeker and Juliusberger, *Neurol. Centralblatt*, No. 17, 1897.

Examined by the Marchi method one usually finds wellmarked Wallerian degeneration, which may be traced up through the medulla, pons and capsule to the cortex, and is due to destructive changes in the cerebral cortex of one hemisphere; it is associated clinically with unilateral epileptiform seizures and hemiparesis or hemiplegia; sometimes with hemianæsthesia and hemianopsy, Cases 45, 54. (b) Bilateral, but usually unequal, degeneration of both crossed and both direct pyramidal tracts, which can be traced up to the cortex, associated clinically with severe bilateral epileptiform convulsions, and sometimes opisthotonus or emprosthotonus. The acute vascular changes in the cerebral cortex may be due to arterial thrombosis, brought about by syphilitic endarteritis, causing localised and general softening; this, however, is extremely rare. Occasionally it is an arteriosclerosis with multiple miliary softenings, and still more frequently examination of the brain shows vascular stasis, blocking of veins and capillaries, which may, in rare cases, proceed to thrombosis of the large veins opening into the longitudinal sinus, and cause red softening. frequent cause, however, is the characteristic chronic inflammatory affection of the cerebral cortex of typical general paralysis, with marked irritative cell proliferation of the capillaries and within the perivascular lymphatics. the degeneration of the pyramidal tract is unilateral, or more marked on one side than the other, there is invariably a greater wasting of the corresponding hemisphere, which contains the cells from which these fibres take their origin. In no case does the examination of the cortex show that the changes are solely of vascular origin; the atrophic process is partly due to chronic progressive atrophy, and partly due to acute degeneration. Thus we find the tangential fibres absent or greatly diminished in the prefrontal region of both hemispheres in cases where there is only unilateral pyramidal degeneration and unilateral fits. The cortical changes will be referred to in fuller detail later on. It may, however, be remarked that in all cases where there have been prolonged epileptiform seizures of recent, but not too recent, date, Wallerian degeneration in the pyramidal systems was found.

and the second

Each seizure, whether maniacal or epileptiform, connotes cerebral irritation, vascular reaction, with cell proliferation and acute neuronic destruction, consequently a series of seizures will be followed by a series of degenerations. The appearance presented, however, by the degenerated fibres is not quite like that produced by experimental lesions. A section of the pyramidal tract stained by Marchi method

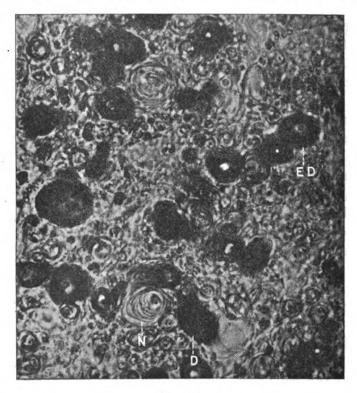


Fig. 45.

Photomicrograph of the right crossed pyramidal tract upper dorsal region of cord (Case 54). Marchi staining; magnification, 750. The smaller intervening undegenerated fibres are partly commissural ground fibres.

shows normal fibres, N; fibres in which the sheath stains black, but still retaining an axis cylinder, E D; others black throughout, indicating complete degeneration, D; lastly, empty spaces, indicating destruction of a fibre and absorption of the products. The smaller black degenerated fibres may be terminal branches of the pyramidal fibres.

In those cases of tabo-paralysis in which the disease is characterised principally by a slow progressive dementia without epileptiform seizures, and in which microscopical examination shows a chronic atrophic degeneration of the neurons, affecting especially the molecular layer and the small and medium-sized pyramids with the corresponding atrophy of their association fibres, there is very seldom (and when present but very slight) Marchi reaction of degeneration; likewise there is no Marchi reaction of degeneration in the posterior columns in cases of chronic tabes dorsalis. of the spinal cords of these cases of tabo-paralysis were remarkably small, some not any larger than that of a child of two years (Cases 31, 52, 57), and this small size can only be explained by supposing that there is a general failure in the metabolic processes of nutrition of the nervous system. In tabes dorsalis the dwindling in size of the myelin sheath and its eventual disappearance, usually without any evidence of the Marchi reaction, makes one believe that there is a slow progressive process of failure in constructive metabolism of the neurons. The myelin sheath, together with the collaterals, which are the latest development of the neurons embryologically, are the first to suffer; and why in one case the brain, in another the cord, or in some both fail, can only be explained by the intervention of some contributory factors which determine a locus minoris resistentia, such as vascular supply, stress, and heredity.

Changes in the Anterior Horn Cells.

In advanced cases of tabes, various deformities arise in consequence of amyotrophy; the small muscles of the hand and foot are specially affected, also the muscles of the leg, particularly the peronei and dorsal flexors, giving rise to various forms of club foot. Electrical examination of the muscles usually shows no reaction of degeneration, but in rare instances, e.g., Case 49, it does. Occasionally this may be due to chronic lead poisoning, as described in a case by Redlich, who claims that a typical posterior column degeneration of tabes was produced by lead poisoning, independent of syphilis; associated with it, however, was a chronic anterior polio-myelitis.

Some cases of progressive general paralysis apparently are

due to chronic lead poisoning, and the fact that a tabic 1 lesion of the cord can be produced by this cause, tends to support the unity of the two diseases.

It is only in advanced cases of tabes that one finds changes in anterior horn cells, and it is probable that these changes are due to total destruction of the sensory neurons which are in relationship with them. Warrington has shown that section of a large number of posterior roots produces chromolytic changes in these cells. I have been rather astonished at not finding more evidence of this in tabes and in the sections which I have prepared from cords of animals in which posterior roots have been cut. Possibly this was due to the fact that the animals were kept alive a much longer time than those of Warrington. Again, in cases of tabes, where there has been a very complete degeneration of the posterior roots, I have failed to find these chromolytic changes; but when such have been seen (besides the destruction of the posterior roots), there was a very marked atrophy of the endogenous fibres of the posterior columns. This atrophy prevents stimuli entering from other regions in which the roots have not been completely destroyed, and marked changes, indicating progressive nutritional failure and even, rarely, atrophy of the anterior horn cells may occur. A similar condition of the cells was observed in a case of very chronic rheumatoid arthritis, with muscular atrophy. the muscles responded to electrical stimuli, but owing to the joint affection, a progressive change, presumably, took place in the anterior horn cells; their dendrons were broken off, the cytoplasm contained an excess of pigment and a diminution of the Nissl bodies.

In Case 49 of tabes, in which the change in the anterior horn cells was most pronounced, the cells exhibited the following characters. In the lumbo-sacral region, especially at the level of the first sacral, the anterior horns show the cells having their processes broken off; there is a perinuclear chromatolysis and marked excess of pigment. There is no marked proliferation of the intervening glia substance, as the

[&]quot;Tabes Dorsalis und chronische Blei-vergiftung." Wiener Medicinische Wochenschrift, 1897.

accompanying photomicrograph shows. This case was one of arm tabes, and many years before he died the notes state that there was complete analgesia and anæsthesia of the arms, a very unusual condition in tabes, as the anæsthesia very rarely extends to the distribution of the upper cervical roots. Then it was noticed that there was a progressive wasting in the small muscles of the hand, more marked on one side than the other, with eventually reaction of degeneration. Microscopic examination of the cord in the cervical regions showed an atrophic degeneration of the anterior horn cells in the upper two dorsal and last cervical segments, with a complete absence of fibres in the posterior roots and pos-

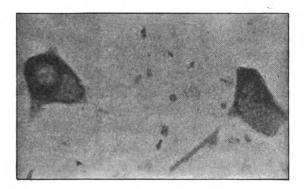


Fig. 46.

Case 49.—Amyotrophic tabes, anterior horn cells, first sacral segment showing chronic degenerative changes, breaking off of processes and excess of pigment. Magnification 300 diameters.

terior columns of the segments of the spinal cord which correspond to the origin of the fibres which enter into the formation of the brachial plexus. There was a considerable atrophy of fibres also in the upper cervical segments; probably, therefore, owing to the accompanying destruction of the ascending and descending endogenous system of fibres in the posterior columns, all direct and indirect reflex spinal stimulus to the anterior horn cells had been abolished for many years.

We can explain amyotrophic tabes in two ways: either the atrophy of the anterior horn cells has been brought about by a superadded chronic polio-myelitis, or the extreme tabic atrophy of the sensory neurons, which are in relation with those segments, has given rise to a secondary trophic change from the abolition of the stimuli incidental to their vital activities, similar to that which occurs in the sensory neurons after amputation of a limb. This latter hypothesis seems probable, even though we found in the small muscles of the hand the very unusual condition of electrical changes; but then the affection was essentially the same as in the small muscles of the foot, only of longer duration. The microscopic changes met with in the first sacral and ulnar segments of the cord were essentially the same, although the latter was more advanced.

Why are the small muscles of the hand and foot so frequently affected by this amyotrophy, as compared with the large trunk and limb muscles? The latter may derive some reflex tonus by impulses descending from the cerebellum, partly incited by afferent impressions from the semicircular canals (vide experiments of Bickel and Ewald) partly by peripheral afferent impressions transmitted by the posterior roots through Clarke's column to the ventral and dorsal cerebellar tracts, which are cut off in tabes.

Again, we have seen that an important association system of descending endogenous fibres of varying lengths exists in the posterior columns, that it is seldom entirely destroyed (only in the most advanced cases), and that these fibres in the dorsal and upper lumbar region are brought into relation with the anterior horn-cells and the cells of Clarke's column at different levels, consequently stimulus may enter the cord in regions where roots are, in the vast majority of cases, still partially preserved. By means of these association fibres of the posterior columns distant neurons in Clarke's column and in the anterior horns may be affected, and thus preserve their nutritional and functional activity, and a certain amount of reflex spinal and reflex cerebellar tonus of the muscles. This is probable, seeing that the distribution of cutaneous anæsthesia and the microscopic examination of the roots and spinal segments of a large number of the cases which I have recorded indicate that the roots which longest maintain function and structure are the cervical above the seventh, the lowest dorsal and upper lumbar; while the regions most likely to be affected are the lowest lumbar and upper sacral, the upper dorsal and the lowest cervical (vide figs. 3 and 4).

It was only in a case of arm tabes where there was during life evidence of affection of all the cervical roots by a complete anæsthesia of the arm that an amyotrophy in the upper limb was observed, although it was noticed several times in the foot. When it occurred in the foot there was always a very marked degree of analgesia and anæsthesia of the legs, indicating a very complete posterior root destruction in these regions. These synergic association systems subserve spinal co-ordination, and their degeneration plays an important part in the later stages of tabes.

Changes in the Optic Nerves.

In eight out of twenty-eight fatal cases (nearly 30 per cent.) there was optic atrophy with blindness. Microscopical examination of the optic nerves was not made in a good number of the cases, therefore exact statistics cannot be quoted, but probably 60 per cent. of the cases would show some degree of optic atrophy. The clinical history of some of the cases would suggest that the optic atrophy is not always primary, but may in some instances be due to syphilitic basic meningitis. Microscopic examination, however, does not help to decide. In several cases in which there was no definite naked-eye optic atrophy, one found a diffuse degeneration by Marchi method, also a large number of empty spaces as if fibres had disappeared. Case 54 was remarkable in the fact that the optic nerves were smaller than natural, yet microscopically showed no overgrowth of glia tissue. The component fasciculi of the nerves were small, as if there was a general atrophy as inexplicable as the small spinal cord so frequently met with. In several advanced cases the retina was examined (vide Case 65).

Developmental Defects.

In three cases (41, 46 and 61) out of the twenty-eight examined there was a true heterotopia spinalis. As I have

examined a very large number of spinal cords, normal and abnormal, but have never met with this condition except in these three cases of tabo-paralysis, it must be something more than coincidence that 10 per cent. of tabo-paralytics should have this defect; it supports the opinion of those who maintain that an hereditary deficiency may be an important causative factor in the production of the disease.

Morbid Anatomy of the Brain.

The changes in the brain in tabo-paralysis do not differ essentially from those of ordinary paralysis, except that, generally speaking, they are not so advanced, and are of a more chronic nature.

Pachymeningitis was rarely met with in these cases; the brain was seldom greatly wasted, and if it were so, it was generally one hemisphere which was markedly affected, due to acute vascular changes affecting extensively one hemisphere, associated during life with epileptiform seizures and hemiparesis, aphasia, and, occasionally, hemianæsthesia and hemianopsy. The pia-arachnoid membranes were thickened in proportion to the atrophy in the usual situation—the fronto-central regions, but the thickening was seldom very marked. In some cases the naked-eye signs were so slight as to require microscopical examination for confirmation, and in these the clinical symptoms were usually hallucinations and delusions with little dementia. The dementia, as pointed out by Dr. Bolton, was found usually proportional to the degree of wasting, but not always. The most marked changes in these early cases was found both macroscopically and microscopically in the orbital and pre-frontal regions, which occasionally exhibited a granular surface like a cirrhotic kidney.

The lateral ventricles were dilated in proportion to the atrophy of the hemispheres. In several cases there was marked dilatation of the posterior part of the lateral ventricle, so that it extended within half an inch from the tip of the occipital lobe. This was found to be due to atrophy of the fronto-occipital and temporo-occipital fibres especially. The ependyma was usually granular, but not in the early cases;

the fourth ventricle exhibited dilatation of the lateral sacs, and granulation of the surface in every case. This condition, however, is met with, and, indeed, all the other naked-eye signs to some degree, in all cases of chronic insanity with wasting, but it is seldom that one finds granulation of the floor of the fourth ventricle covering the calamus scriptorius in any other affection than progressive paralysis; it was present in even the earliest cases of tabo-paralysis; when there was no appearance of granulation in the lateral ventricles it was found in this situation. In other brain diseases, in which there may be just as much wasting of nervous tissue, there is nothing like the same amount of ependymal change, consequently in this disease, progressive paralysis, there must be some difference in the cerebro-spinal fluid or the capacity of formative reaction of the lining epithelium and glia tissue to account for this excessive granulation. I regard this, like the filling up of the central canal of the spinal cord, as an exaggerated formative proliferation of embryonic and glia tissues brought about by irritation, and this fact is of importance when placed by the side of other facts denoting bio-chemical toxic irritation.

Vessels.—As I have shown elsewhere, if all the vessels of the brain, even in young people suffering with paralysis, be pulled out and washed with water, a few nodular patches of atheroma can be found in a considerable number of the cases, but this change may be regarded as merely a sign of previous syphilitic infection, and plays no part in the pathology of the morbid process. Only in cases of people who have passed 45 does one find any really marked change in the cerebral vessels, and then it is doubtful whether this change plays any important part in the production of the morbid process; it is merely a sign of pre-senile decay, and probably of the action of the syphilitic virus, especially when considered by the side of another fact, namely, the presence of atheroma of the aorta—a pathological condition found in the great majority of cases of progressive paralysis -more than 80 per cent. This condition is found even in young juvenile cases.

In none of the twenty-eight cases referred to in the 19

synopsis was there noted thrombosis of the veins opening into the longitudinal sinus, causing red softening; this, however, I have seen in cases of progressive paralysis giving rise to epileptiform seizures, unilateral or bilateral, according as the process affected one or both hemispheres, and followed by hemiplegia, first of one side, then of the other, causing death, usually with hyperpyrexia. Syphilitic endarteritis was not met with in any of these cases, but I have seen it several times in cases of progressive paralysis.

Microscopic characters of the disease may be considered under three headings:—(1) Changes in the nervous elements, cells, and fibres; (2) changes in the glia tissue; (3) changes in the vessels.

(1) I do not propose to give a long description of the changes met with in the nerve-cell, for they in no way differ from those met with in ordinary paralysis, and these changes are admirably described by Dr. Watson.

Comparing, however, a large number of sections of experimental anæmia, tabo-paralysis, and general paralysis, I have formed the conclusion that the changes in the nervecells are of two kinds, acute and chronic; that the chronic process begins in the superficial layers of the cortex, small and medium-sized pyramids, and the molecular layer. The changes are slow and insidious; the cells and their fibres undergo an atrophic process without any marked inflammatory reaction. The acute process, on the other hand, occurs in paroxysms, and is associated with the formation of an acute irritant toxin having a local action, and causing, partly by its own chemical properties and partly by the inflammatory reaction of the vessels with capillary obstruction, an acute coagulation necrosis of the cells very similar to that produced by ligature of the four arteries supplying the brain in cats and monkeys, which is invariably followed within twenty-four hours by a fatal result, preceded by epileptiform fits. (Dr. Leonard Hill's experiments.)

The cells stain diffusely, the Nissl granules are absent, and the chromophilous substance takes the form of a fine dust throughout the cytoplasm, the achromatic substance not being visible as the whole of the protoplasm is stained.

If Unna's polychrome or a mixture of methylene blue and saffranine be used, the cells are stained a pinkish purple, indicating an acidophil, instead of basophil reaction.

The nucleus is often swollen up and clear, the nucleolus staining deeply by contrast.

I have observed that the small and medium-sized pyramids, in cases with acute symptoms terminating fatally, show a very similar condition to that which I have observed in acute fatal experimental anæmia—namely, the nucleus swollen like a bladder to five or six times its size, clear, and surrounded by a thin film of cytoplasm; the nucleolus deeply stained, the intranuclear network faintly. In proportion to the destruction of the nerve-cells, there is, as a rule, but not necessarily, an overgrowth of glia-cells and vascular changes, which will be shortly considered.

The neurons may be entirely destroyed, or only a small, irregular, triangular mass of protoplasm be left; or the larger processes may still persist, but present no Nissl granules, and exhibit no dendritic processes. Often the apical process is like a corkscrew; this condition I have found in imbecile brains, and I look upon it as evidence of a chronic process of atrophy.

Such morbid conditions destroy the normal lamination of the cortex and the characteristic columns of Meynert.

Occasionally I have observed cells with a nucleus undergoing division; this I have seen in absinthe poisoning, and I regard it as a sign of intense irritation. Salaman, in the first volume of the Archives, described a case of taboparalysis, in which he observed division of the nucleus in the cells of the posterior spinal ganglion.

As Tuczek pointed out, atrophy of the tangential and supraradial fibres is the earliest and most constant microscopic change met with in general paralysis. None of the twenty cases which were examined failed to show this change to some degree; but I do not remember one case in which the Marchi method showed recent degeneration of the tangential system. Possibly the method does not lend itself to showing destruction of these very fine fibres—more likely, however, it is that the process has taken place, and the products of

destruction have been absorbed, or that as in tabes, the process is slow and progressive. When atrophic changes in these fibres could not be discovered in other regions of the brain, they were invariably found in the prefrontal, and usually in Broca's convolution. Many of these cases showed a marked atrophy of the tangential system in the ascending parietal and the paracentral lobule, more marked than in the ascending frontal. I thought possibly this might be associated with the fact of the degeneration of the afferent system, but Campbell has shown that the ascending frontal normally possesses a greater wealth of tangential fibres than the ascending parietal; it is likely that this is associated with the presence of the Betz cells, the apical processes of which terminate in a panniculus, as shown by Cajal, in the molecular layer. It was frequently noticed that in one section there would be a considerable local disappearance of tangential and supraradial fibres, and we must account for this by the fact that there was a local atrophy of cells corresponding thereto. In fact, Nissl preparations clearly show this, and frequently there is not a uniform disappearance of cells in the superficial layers, but frequently little foci of atrophy.

In Case 28, which we may consider as either one of tabes commencing with a mental crisis, or as tabo-paralysis with arrest of the cerebral disease and progress of the spinal, this unequal destruction of the tangential and supraradial fibres was especially observable. In that case, moreover, page 23, the atrophy and thickening of the membranes (see Plates I. and II.) were much more marked over the ascending parietal in its upper part than the corresponding portion of the ascending frontal. There were no acute changes in this case, and the superficial cells, beyond a certain amount of diminution in numbers and therefore thickness of lamination, presented no abnormal appearances. This was the only case observed which would at all correspond with cortical changes in tabes to which Jendrassik first called attention. Many people think that his cases were really tabo-paralytics, and I see no reason why they should not have been. For if Case 28 had died in the attack of mania, I should certainly have described it as a case of tabo-paralysis; instead of this, he survived thirteen years.

The atrophy of these superficial fibres is by no means limited to the fronto-central regions, although it is more marked there as a rule. Every part of the cerebral cortex may exhibit this change and sometimes it was found marked in the angular, temporal and occipital regions. In advanced cases, the interradial and, to a less degree, the radial fibres, were found atrophied, but as a rule these were not affected, excepting in cases of marked wasting of the brain. staining by the Weigert method it was often found that the myelin did not take the stain readily, behaving in this respect like fœtal or infantile tissue and agreeing also with what was noted about the difficulty of staining the spinal cord in some of the cases. By the Marchi method the radial fibres were often found in a process of acute degeneration, especially where there was marked wasting of one or both hemispheres and signs of acute vascular changes. Such cases were found to show marked recent degeneration in the pyramidal systems in the cord, and indicated an acute death of the large Betz cells, from which these pyramidal fibres proceed. But we have seen that in twenty cases of the twenty-eight, there was degeneration and sclerosis of the crossed pyramidal tracts in the cord which could not be followed higher than the lower or mid-dorsal region. We can only account for this by a nutritive failure of the psycho-motor neurons, a chronic atrophic process affecting the most outlying portions of the neuron, most remote from the central seat of trophic influence, the nucleus of the cell. This presumably slow degenerative process of the crossed pyramidal tracts cannot be explained by any vascular or local condition of the spinal cord, or other long tracts in the lateral columns would be The only explanation to my mind is the one I affected. have given.

(2) Glia proliferation.—This is so very completely described by Dr. Watson that I need not do more than say my observations, made subsequent to his investigations, confirm the results which he has described. I hope to publish shortly also observations showing that atrophy produced by experimental lesions can produce active glia proliferation. There is one point, however, in connection

with glia formation which is not dealt with by Dr. Watson, and this relates to the evidence that the cerebro-spinal fluid in progresssive paralysis may contain some substances which, by irritation, produce formative proliferation. In three cases there was heterotopia spinalis; in one, Case 46, a careful study was made of the changes in the epithelium lining the dilated canal. By the Marchi method the epithelium was seen to contain numbers of black particles, presumably products of fatty degeneration. By Mallory stain a formative proliferation was apparent in this epithelium, not limited to the posterior surface where the tabic process in the posterior columns was adjoining, but affecting the whole epithelium. I mention this latter fact because it supports the view that this active formative proliferation was not related to a substitution process, but rather to an irritant action of the fluid contained in the central canal. It will be remembered that this case died in epileptiform seizures, and, as I will shortly point out, an acute vascular irritant formative process is the most significant of all the signs of progressive Examination of this epithelium (see photomicrograph, Plate VIII., fig. 1) shows the nuclei of the cells undergoing an active proliferation; the nuclei, on account of the chromatin they contain, were deeply stained blue, and surrounded by a granulous pink-staining protoplasm, resembling the spongio-blasts of the embryonic tissue of the central nervous system.

The nuclei of these spongio-blasts can be seen dividing to form two or even a column of cells. From the base of the epithelial cells long fibrous strands, passing deep into the substance of the cord, can be seen, and in the spaces intervening these embryonic glia cells are packed. I could then trace, proceeding outwards from the central canal, successive changes in the appearance of the glia cells very similar to those described by Dr. Watson.

It is a well-known fact that in most chronic nervous diseases, and in old people, the central canal becomes filled up, but in quite young people suffering with general paralysis, or with Congo sickness, diseases in which there is other evidence of intense irritation, the central canal becomes

filled up, and its place marked by a great number of embryonic glia cells, similar to those which I have described above. The epithelium lining the canal, from which presumably these cells originated, has disappeared, owing to, probably, the pressure and consequent atrophy caused by proliferated glia cells.

(3) Vessels.—The most constant and striking change which can be observed in progressive paralysis is afforded by the appearances presented by the vessels. Under a low power in an acute severe case of this disease there is such a proliferation of cells on the vessel walls and in their surrounding lymphatics, which stain deeply with basophil dyes, that it almost appears as if the stained substance which was previously contained in the neurons had been transferred to these cells around the vessels. The more acute the symptoms and the more rapid the progress of the case, the more obvious is this vascular change. What is it? What does it signify?

Vogt has stated that plasma cells, which he regards as altered lymphocytes, are the cause of such an appearance of the vessels, and pathognomonic of the disease.

Mahaim, on the other hand, considers lymphocytes pathognomonic of the disease; Havet, although he admits that plasma cells are found in general paralysis in nearly all cases, does not admit that they are pathognomonic.

These plasma cells are not peculiar to the brain; they were first described by Unna, and he considered them as fixed tissue cells which have undergone proliferation. Marscholko has shown that they can be found in glanders, syphilitic granulomata, tubercle, lepra, carcinoma, and other diseases; and he believes they are altered lymphocytes.

The experiments of Cornil and Ranvier in the recently published edition of their "Pathology," show that irritation of the serous membranes by chemical substances can produce a proliferation of the endothelial cells in all respects resembling these plasma cells.

Pappenheim has recently introduced a differential stain whereby the nuclear chromatin substance is stained green and the surrounding granoplasm of the cell pink. The ordinary Nissl method for staining nervous tissues was used by Vogt, thionin by Havet. Unna's polychrome is useful also, for it stains the granoplasm pink, the chromatin substance purple.

The Unna-Pappenheim stain, when it succeeds, shows more clearly than any other the morphological characters of the plasma cells; also their close relation to lymphocytes.

Lymphocytes.—The nuclear network of the lymphocyte is stained green; from a central nucleolus, like the spokes of a wheel, fine strands of chromatin extend to the nuclear membrane, ending generally in little knots. The nucleus, as a rule, is surrounded by hardly any cell protoplasm. Lymphocytes are not often seen in the blood contained in the vessels, but single, in pairs, or groups, in the perineuronal and perivascular spaces, in the cerebro-spinal fluid and subarachnoid space. They occur in normal brain tissue. Occasionally lymphocytes may be seen with a certain amount of granoplasm stained pink, partially surrounding, like a half-moon, the nucleus. These may be transitional, and probably represent young forms of the plasma cells of Marscholko.

Origin of the lymphocytes.—(a) The Blood. Dr. Pugh has found an increase of lymphocytes in the blood of epileptics during the fits. Dr. Boddington has kindly allowed me to refer to some unpublished observations which he has made, showing that during the second stage of general paralysis there is a considerable increase of the lymphocytes in the blood.

DR. BODDINGTON'S RESULTS.

[It is not certain that the increase per cubic mm. is due to an arterial increase, as the total volume of blood has not been measured; but it is remarkable that in these conditions it appears viscid, and flows with difficulty.]

This high percentage of polymorphonuclear cells during the seizures is a marked contrast to the condition found in cases of status epilepticus, in which, during the fits, there is an increase of mononuclear cells, chiefly lymphocytes, which latter may form 40 to 50 per cent. of the total.

Immediately following the status there is an increase of polymorphonuclear cells, even up to 90 per cent.; this, however, is quite transitory, lasting for twelve to twenty-four hours, whereas this high percentage in paralytic seizures continues for fourteen days, or more, and the return to the condition normal to the patient before his attack may take four or five weeks to

accomplish. Myelocytes to the amount of 1 per cent. are seen in status epilepticus.

In the second stage of general paralysis the blood differs from that of a healthy individual in that the percentage of mononuclear cells is increased so as to form 40 per cent. or more (in some few cases as much as 60 per cent.) of the total white cells, and of these considerably more than half are lymphocytes.

In the third stage there is an increase of polymorphonuclear cells,* which

amount to 80 or 85 per cent. of the total white cells.

In the convulsive seizures of the second stage there is a very marked and sudden increase in the total number of cells per cubic mm., so as to form in the course of a few hours six or seven times the normal number; and this increase consists almost wholly of polymorphonuclear cells, which form 90 to 95 per cent. of the total. At the same time there is a total disappearance of eosinophils, and myelocytes appear in the blood.

Examination of sections of the brain from a large number of cases of various diseases in which there have been fits prior to death, including five cases of status epilepticus, has shown the existence of excess of lymphocytes in the perineuronal spaces. These may come from the blood, but lymphocytes are not usually regarded as capable of active migration through the vessel wall. They may, however, be derived from lymphocytes normally existing in the lymph spaces of the tissues. Pappenheim regards this as probable. We may therefore conclude that the altered condition of the blood which is associated with the fits may cause a stimulant and proliferative action on the lymphocytes of the blood, and especially at the primary seat of the morbid process—the brain.

After examination (by one of the methods related) of an immense number of sections of the brain and spinal cord of the various forms of nervous disease and experimental lesions enumerated below:—

Twenty cases of experimental anæmia (dogs, cats and monkeys), by Dr. Leonard Hill.

Cases of abrin, ricin and botulin poisoning, by Dr. Durham.

One case of sunstroke.

Two of pernicious anæmia.

One stab in the heart (probably man suffering with acute alcoholism).

One leukæmia.

One exophthalmic goitre.

*The polymorphonuclear cells may, however, be due to terminal infection. (F. W. M.)

Two beri-beri.
Five status epilepticus.
Two acute alcoholism.
Five alcoholic dementia and polyneuritis.
Two amyotrophic lateral sclerosis.
Five cases of juvenile paralysis.
Twenty cases of tabo-paralysis.
Ten cases of general paralysis.
Two cases of Congo sickness.
Two cases of multiple syphilitic gummata.

I came to the conclusion that the plasma cells of Marscholko described by Vogt as pathognomonic of general paralysis, and which will now be described, are almost pathognomonic of this disease. I say almost, because I found them in a case of Congo sicknesss with fits (vide fig. 7, Plate XI.), and I failed to find them in one case of juvenile general paralysis. These cells contain a nucleus very like the nucleus of a fully-developed lymphocyte, viz., a central nucleolus with wheel-like strands of chromatin ending in four to seven knobs beneath the nuclear membrane. Like the nucleus of the lymphocyte, the chromatin stains deeply green, whereas the granoplasm around the nucleus is stained pink by Pappenheim's method: very frequently there is a clear halo between the nucleus and the granoplasm. The plasma cells are of varying size, from 7 to 14 μ , they are polygonal, oblong, oval or triangular in shape; the green-stained nucleus is usually at one end of the cell; frequently two cells having their nuclei in opposition indicate cleavage. Many of the cells show an endogenous nuclear proliferation. The granoplasm contains a fine dust of particles stained pink and no coarse granules, so that it has a grumulous appearance. These cells lie like a plaster on the vessel wall (vide figs. 3, 5, 6, 7, Plate VIII.).

In the neighbourhood of vessels so affected one always find a proportionally marked acute destruction change in the neurons.

In some cases of tabo-paralysis in which there had been no fits, and death had occurred within a short time of the onset of mental symptoms, the prefrontal and orbital regions of the cortex alone may show naked-eye changes of the lesions characteristic of general paralysis, and it may be only in such regions that the plasma cells will be found. (Case 39, p. 156.)

In cases where there has been marked spinal affection these cells have been found in great abundance around the vessels in Broca's convolution, the island of Reil and the posterior third of the first temporal. (Cases 46 and 54.)

We may associate their existence in abundance with intense irritation, increased neuronic irritability followed by degenerative destruction. The former case was not paretic in the limbs; his speech, however, was markedly affected, and facial paresis existed. Accordingly, marked plasma cell proliferation and acute neuronic destruction was found in Broca's convolution and the lower part of the frontal and parietal convolutions, and but little in the second frontal and adjacent motor area. In Case 54, on the other hand, there was marked sensory aphasia, hemiparesis, and transitory hemianæsthesia; plasma cells in abundance and acute cell destruction were found in the angular, supramarginal and first temporal of the left hemisphere.

Plasma Cells proportional to Acute Neuron Irritation and Destruction.

The plasma cells of Marscholko were found in all cases of general paralysis and tabo-paralysis examined; they were not found in the brain of any other of the conditions enumerated, with the exception of one case of Congo sickness, and one of multiple syphilitic gummata. They were not numerous in the Congo sickness, and required much search (vide fig. 7, Plate VIII.), although the perivascular lymphatics throughout the whole central nervous system were crowded with lymphocytes in a way that I have never seen in any other disease. Sections of the spinal cord, medulla, and pons in tabo-paralysis and general paralysis did not show these plasma cells around the vessels.

They exist especially in those regions (fronto-central) of the brain which generally show wasting in general paralysis, and their abundance is clearly associated with the amount and the intensity of the acute neuronic irritation and destruction.

Endothelial Cells as the Origin of the Plasma Cells.

The endothelial cell proliferation is marked in all cases where there is active destruction going on. The nuclei of the capillaries increase in numbers and can be seen under-This proliferation of the endothelial cells going mitosis. would tend to obliterate the lumen of these delicate tubules and obstruct the passage of red corpuscles, thus interfering with tissue respiration and the removal of the waste products Endothelial cells proliferate in the of neuronic activity. vessels of the spinal cord, or at any rate, there is an increase of the nuclei; but I have never observed plasma cells in the gray matter of the spinal cords of paralysis cases. A good way to study the endothelial proliferation of the capillaries is to make film preparations of fresh cortex squeezed between two cover-glasses (vide fig. 4, Plate VIII.). The capillaries can be traced into the venules; the proliferated endothelial cells can thus be determined. The walls are no longer clear with a delicate outline, but consist of a granoplasm with increased numbers of long nuclei. As you pass from the capillary to the venule the nuclei become more oval, and the proliferated cells take on the form of plasma cells: but it may be argued that these cells may arise from the endothelial cells of the lymphatics surrounding the small venules, or lymphocytes contained in the sheath.

I have observed plasma cells in the perineuronic spaces and in the tissue away from vessels; moreover, the much closer resemblance of the nucleus of the lymphocyte in shape and arrangement of the chromatin, together with the occurrence of transitional forms between lymphocytes and plasma cells, inclines me to alter my original opinion and conclude that the balance of evidence is in favour of the plasma cells being derived from lymphocytes and not from endothelial cells, although the latter undoubtedly undergo active proliferation.

The proliferated endothelial and plasma cells seem to

have a phagocytic function, for we can find blood pigment in various stages of disintegration and chemical change within them.

What is the pathological significance of these plasma cells in the brain in general paralysis?

The clinical symptoms associated with the anatomical findings undoubtedly show an intense irritant morbid process, followed by acute neuronic destruction. But, as already remarked, plasma cells are found in many other morbid processes where acute irritation and destruction is occurring; therefore in general paralysis they are only indicative of an acute irritative process in the brain.

We have next to consider the source of the irritant, which, presumably, is of a bio-chemical nature, and produced paroxysmally by a localised conspiracy of factors; for if some toxin or autotoxin generalised in the blood were the sole factor, then we ought to find its effects manifested equally throughout the nervous system, but it is not.

Those portions of the hemispheres, the veins of which drain into the longitudinal sinus, are the regions in which venous stasis is most apt to occur, for the following reasons: The blood flows against gravity; the veins embouch into the longitudinal sinus in a contrary direction to the current; the suction action of the thorax influences the flow from the lateral sinuses first; consequently violent expiratory efforts and suspension of respiration leading to cerebral congestion, or any general condition of venous plethora from portal congestion, would, owing to these mechanical disadvantages, tend to stasis in the fronto-central regions. Again, the brain, being contained in a closed cavity, the quantity of blood in the organ is always the same, therefore if vaso-motor irritation causes sudden anæmia from diminution of arterial supply, a proportional reflux of venous blood would take place and tend to flow into these regions. the portion of the brain most likely to suffer from sudden anæmia is the portion supplied by the internal carotid (viz., fronto-central), because the force of gravity would operate most on the blood contained in the distribution of this vessel. Therefore the morphological conditions of the arterial and venous circulation in the fronto-central regions favour anemia and venous congestion.

Slight faints and lapses of consciousness are among the earliest prodromal signs of general paralysis, and are indicative of these vascular disturbances. These, however, are subsidiary, but important exciting and determining factors in the disease.

The paroxysmal character of seizures, followed by apparent betterment, the microscopical evidence of an intense irritative and destructive process more obvious than in almost any other brain disease, point to the formation in the blood of a toxin which fixes on to certain portions of the central nervous system, which either stress, heredity, or anatomical conditions place in a lowered state of resistance. If the vascular factor alone were a cause, heart disease should be a cause of general paralysis. The paroxysmal attacks in tabes, of lightning pains, of visceral crises, of mental crises, followed by intervals of relief, all point to some coming and going of an irritant which acts upon decaying structures.

The mania and grandiose delusions which frequently subside, and the paroxysmal character of the epileptiform seizures, point to the formation of a toxin or accumulation of a toxin in the blood, which produces an effect, but is destroyed to accumulate again. The observations of Krafft-Ebing strongly support the view that general paralytics possess an immunity to syphilis; it may be presumed that the effects of the toxin are still in operation. He inoculated eight general paralytics, who exhibited no signs of syphilis, with the virus of a hard chancre, and they showed no signs of infection subsequently when watched for 180 days.

As in diphtheria, the general toxic action of syphilis altogether overshadows, and, indeed, often bears no proportional relationship to the local effect of the contagium, especially in the late after-effects. Experiments of Ehrlich, confirmed by Bulloch, seem to show that there are a mixture of bodies in the crude toxins of diphtheria. Likewise Ehrlich and Madsen have shown that certain bouillon cultures of the tetanus bacillus may contain two toxins, a

tetano-lysin, and the ordinary spasm producing body tetanospasmin. Unfortunately, owing to the absence of our knowledge of the specific germ of syphilis and the immunity of all animals to infection, it can only be deduced by analogy that Hitzig is probably right in supposing that the syphilitic virus may convey several poisons, one of which may be latent, and produce these late manifestations, tabes and general paralysis. Like diphtheritic paralysis, these late nervous manifestations bear no necessary relation to the primary local and general constitutional manifestations accompanying the disease. The only difference in the analogy between syphilis and diphtheria is the much slower evolution of the symptoms of the former, and it may be added, as a result, the life-long immunity conferred thereby.

Is it therefore warrantable upon the facts to hypothecate a latent toxin of syphilis which has a special affinity for nervous structures—a toxin which can only operate under certain abnormal metabolic conditions of the neurons. In Professor Welch's most illuminating Huxley lecture he thus referred to the work of Ehrlich and Preston Kyes:—

"Preston Kyes, working in Professor Ehrlich's laboratory, in an investigation just published on the mode of action of cobra venom, confirms the conclusion of Flexner and Noguchi concerning the amboceptor nature of cobra venom. . . . Of great significance is the demonstration by Kyes of still a third substance, namely, lecithin, which is capable, through combination with the venom intermediary body, of completing the hæmolytic potency of venom. . . . The suggestion by Ehrlich and Kyes that possibly the cholin group is the toxophore group of lecithin is interesting. . . .

"Flexner and Noguchi have demonstrated experimentally that, like the hæmolytic, so also the leuco-toxic, neuro-toxic and other cyto-toxic properties depend upon combinations of venom intermediary bodies, with complements contained in the cells poisoned by venom, or in the fluids bathing these cells. The positive demonstration by Preston Kyes of a special class of intracellular complements or endo-complements is unquestionably of great pathological interest, and seems destined to play an important part in many morbid conditions, both with endogenic and exogenic intoxication."

The products of degeneration of nervous tissues are numerous, and consist not only of cholin, but a number of bodies of the lecithin group, being various derivations of protagon. Cholin is the most easily separated and recognised physiologically and chemically, and it is possible that the products of degeneration vary according to the cause and nature of the destructive process. Still there is no evidence to show that these products of degeneration can per se produce the clinical manifestations and morphological changes indicating neuronic irritation and destruction of general paralysis, otherwise we ought to get these changes in other diseases, also destructive lesions of the nervous system. Therefore I think it may be conceived as possible that there is a latent toxin in the blood which combines with endo-complements the products of deranged neuron activity, producing locally (that is, where the neuron metabolism is deranged either by stress, circulatory deficiencies, or hereditary physiological or anatomical defects) an active neurolysin proportional to (a) the amount of latent toxin in the blood, and (b) the amount of endo-complement produced by deranged neuron metabolism. The glia-cell, lymphocyte and endothelial cell proliferation and the presence of abundance of plasma cells are the signs of the local vital reactions of the tissues to this poison and proportional to its amount and intensity. Where nervous tissues are latest developed and most unstable, where venous stasis and anæmia are most likely to occur, and in those structures which are subjected to the greatest physiological activity, there is defective metabolism to be found, and there, on this hypothesis, is formed an active toxin-producing irritation and destructive local effects. The nature of the conspiracy of factors and the vital reaction of the tissues will determine the seat and extent of the acute neuronic irritation and destruction.

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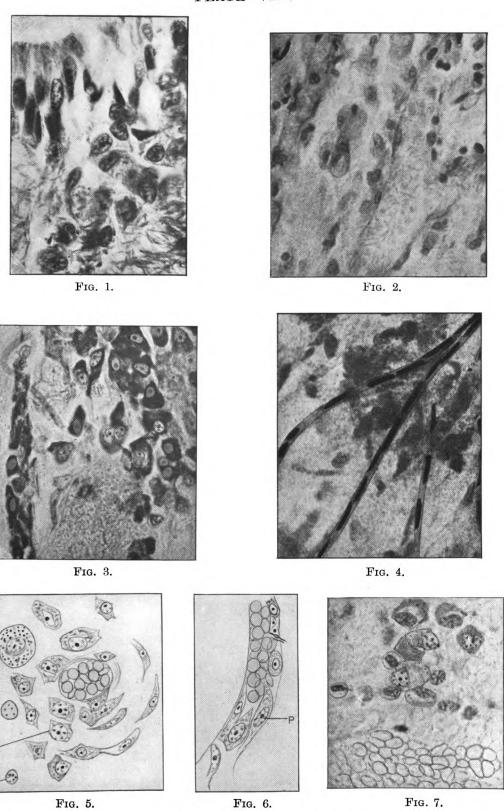
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O = nil. DA = Acute Degeneration. S = Slight Degeneration. m = Moderate. M = Marked. VM = Very marked. + Heterotopia spinalis. ? = Optic nerves not examined microscopically, but no naked-eye change noted. <math>- = Uncertain or not ascertained. This Table is only approximately true, because different levels of the cord may be affected differently in different cases.

PLATE VIII

- Fig. 1.—Photomicrograph of a section of the central canal of the spinal cord with heterotopia, Case 46. The nuclei of the epithelial cells, with their chromatin network, can be seen proliferating; lower down they can be seen surrounded by protoplasm, and undergoing active division. A column of four nuclei surrounded by protoplasm is seen; the upper two nuclei show very clearly two asters, indicating the nuclear division which has occurred. Mallory stain. Magnification, 750 diameters.
- Fig. 2.—Photomicrograph of a section of the ascending parietal convolution from Case 45, showing a small vein surrounded by plasma cells, which are lying in a dilated lymphatic. The vessel at another part had ruptured and filled the lymphatic sheath with blood corpuscles. Some of the large, swollen-up cells showed in their interior the blood pigment in various stages of destructive disintegration; they appear to have, therefore, a phagocytic function. Nissl stain. Magnification, 500 diameters.
- Fig. 3.—Photomicrograph of a section of Broca's convolution, Case 46, showing abundance of typical plasma cells of Marschalko. The cells are oblong, oval, polygonal, and triangular. The granoplasm is dark on account of its taking the pink dye. The nucleus is distinct, with its nucleolus and chromatin strands terminating in chromatin knobs. The nucleus is generally at one end of the cell, indicating active division. In some there is a clear halo around the nucleus. Many of the cells show endogenous nuclear proliferation. The cells are seen stuck on the vessel wall like the corrugated bark of a tree. At the lower end of the section the indistinct forms of the unstained red corpuscles are seen within the lumen of the cut vessel. Polychrome Nissl stain. Magnification, 750 diameters.
- Fig. 4.—Photomicrograph of a film preparation of the vessels stained by Nissl method from a case of general paralysis. It shows the proliferation of the nuclei of the capillaries, the absence of red corpuscles, and the obliteration of the lumen by the endothelial cell proliferation. Magnification, 500 diameters.
- Figs. 5 and 6.—Drawings to show different types of cells around vessels in general paralysis; p= plasma cell, m= mastzell, l= lymphocyte. Magnification, 600 diameters.
- Fig. 7.—Photomicrograph of small vein, case of Congo sickness, stained by Nissl method, showing plasma cells. On account of the specimen being somewhat faded, the negative was not strong; the cells have been retouched, but it represents fairly accurately what could be seen. Magnification, 750 diameters.

PLATE VIII.



TABES IN ASYLUM AND HOSPITAL PRACTICE.

Notes upon the Pathology of Tabes and Tabo-Paralysis.

Leyden was the first to point out that the pathology of tabes depended upon the degeneration of the posterior roots and their intraspinal connections. Westphal, Dejerine and Oppenheim, among others, showed that the peripheral nerves were also affected; but most observers now agree with Leyden that the symptoms of tabes are especially due to the degeneration of the central projections of the posterior spinal neurons.

Every posterior root furnishes fibres to different sensory nerves of the periphery. The cutaneous surface is subdivided into zones or segments, of which each receives its sensory innervation from certain definite posterior roots. These segmental posterior root areas overlap one another, and each receives fibres from two or three contiguous roots. thus be manifest that the area of distribution of cutaneous anæsthesia will be quite different, when it depends upon alteration of the posterior roots and their intramedullary prolongations, to when it depends upon alteration of the peripheral nerves. In tabes, cutaneous sensory dissociation, especially in not very advanced cases, is the rule; whereas it is the exception for an anæsthesia of peripheral origin to exhibit the characters of dissociation. There is, however, not only dissociation of cutaneous sensibility, but also marked subjective and objective sensory disturbances of the deep structures, which may exist independently of cutaneous disturbances. We have already referred to the fact that probably the fine fibres of the posterior roots convey cutaneous sensations, and the coarse fibres sensations from the deep structures; and we have seen, moreover, that clinical observations and morbid anatomy have demonstrated that these two systems may be affected independently.

The interesting observations of Dr. Anderson upon the myelination of the different systems of somatic and splanchnic fibres are of great interest, and should help to throw light on some of the phenomena of this disease. He has shown that both somatic and splanchnic myelinated afferent fibres consist of two distinct sets, which develop

their myelin sheath simultaneously in both splanchnic and somatic posterior roots and peripheral nerves; the two sets of fibres convey impulses respectively from deep structures and cutaneous or epithelial structures.

Taking the myelinated splanchnic fibres, he finds that there is one set which has as its peripheral termination Pacinian corpuscles, contained in the structures of the abdominal viscera and larynx. These large fibres acquire their medullary sheath contemporaneously with the large myelinated fibres, terminating in the Pacinian corpuscles, muscle spindles and end-organs, which are contained in the deep somatic structures. The finer medullated fibres which terminate in the skin, and which are connected with pressure and painful sensations especially, are myelinated contemporaneously with the fine set of medullated splanchnic afferent fibres, which, he argues, supply the epithelial structures of the viscera, and which would endow them with common sensibility. Anderson considers that there is a correlation between the function of the afferent splanchnic and somatic fibres, which have Pacinian corpuscles as endorgans. The irritation of these neurons, he considers, gives rise to the deep pains in the limbs and the pains of the visceral crises.

Microscopic examination of the white rami shows that there are both large and small white medullated fibres contained in them; the large fibres correspond to these large splanchnic afferent fibres from the Pacinian corpuscles. The small fibres are partly efferent, arising from cells of the lateral horn of the intermedio lateral tract, which cells have their long axis directed horizontally, and are found in the thoracic region only, where this outflow of fine efferent medullated fibres takes place. Some of the fine fibres, however, are sensory fibres of the viscera, and subserve a protective function by virtue of the pain which intense stimulation, mechanical or chemical, might cause.

Normally we feel no sensation from our internal organs; when painful stimuli are conveyed by the white rami to the posterior spinal ganglia, thence to the spinal cord, where these flow over into the terminals of the somatic skin

neurons, they give rise to characteristic pains referred to morphologically correlated skin areas (Mackenzie, Head). Thus we may really have an illusion as to the true seat of the pain and the nature of the process occasioning it; our experience, however, will lead to its correction.

Besides pain, there is rigidity of correlated muscles due to a protective reflex, by which the parts are kept as much at rest as possible. The severe pain accompanying it may, as Prof. Sherrington aptly says, be looked upon "as a psychical adjunct of this protective reflex." The pain is, however, much greater in some individuals than others; not because the stimulus is greater, but because the subjective mental attitude of the individual, by a concentration of consciousness to the painful spot, is greater. might logically be asked, would it be possible to concentrate the attention on a viscus of which one has no knowledge by touch or sight, if it were not for the pain referred to the correlated skin area? By no effort of the attention can we imagine the rythmical contractions which are taking place with phasic or periodic regularity in our ureters, bile ducts and gall bladders. It is only when they contract violently in response to intense irritation, that we are painfully instructed by experience and the referred pain, as to the cause.

A great deal of discussion has arisen as to whether the viscera are really painful. I think there can be no doubt that a peculiar dragging and sinking sensation is associated with irritation of the viscera, probably due to stimulation of coarse afferent fibres with Pacinian corpuscles, independent of the sensation in the skin areas. Many of the patients who suffered with gastric crises complained of a deep-seated pain within the abdomen, and no doubt this was due to irritation of the splanchnic afferent neurons which were undergoing destruction in the posterior roots of the mid-thoracic segments.

The accompanying figure (47) illustrates this point.

Cases often attend hospitals for gastric troubles which are thought to be dyspepsia, whereas really they are very mild gastric crises. In severe cases there is no doubt intense irritation, generally with destruction of the sixth, seventh, and eighth posterior roots, conveying afferent splanchnic

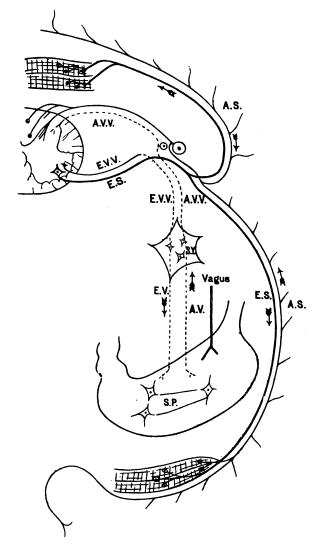


Fig. 47.

Diagram to show somatic and splanchnic nervous structures in the seventh thoracic metamere. The correlation of the skin and muscle in the

protective reflex is indicated.

E.V.V. = Efferent splanchnic; E.S. = Efferent somatic; A.V.V. = Afferent splanchnic; A.S. = Afferent somatic; S.P. = Plexus of Auerbach and Meissner; E.V. = Efferent visceral from sympathetic ganglion; A.V. = Afferent visceral to sympathetic ganglion.

The coarse and fine fibres which exist in both somatic and splanchnic reviews a part differentiated.

nerves are not differentiated.

impressions from the stomach (Case 31). The quality of a sensation depends on multiple circumstances—the nature intensity of the peripheral excitation, the state of the conducting neurons and of the cortical perceptive centres; but whatever be the cause of the objective sensation coming from the periphery, it is in the cortical terminus of the afferent system that the stimulus is perceived as a state of sensation of heat, cold, pain, contact or movement, and localised to a particular part of the body. The localisation is very often imperfect; this is explicable by the fact that each spinal segment of the grey matter of the posterior horns is correlated with a definite skin area. When all the sensory cutaneous neurons proceeding directly to that area have been destroyed, sensory impulses may still enter the cord, owing to the overlapping of adjacent roots in the nervous supply of that skin area, and the stimulus be referred to an In the limbs, where the segmental area above or below. character is obscured, the cause of this imperfect localisation is not so obvious. The wrong localisation is, however, due to a state of consciousness brought about by excitation of neurons in the wrong segment, and consequently is outwardly projected in the mind to that area of skin which is morphologically correlated with the segment excited.

The subjective attitude of the individual (borrowing an expression of Mr. Shand) plays a very important rôle, not only in the subjective disturbances of tabes and taboparalysis, but also in the objective; for often the objective sensory disturbances are erratic and changeable. Thus, where at one moment a patch of anæsthesia or analgesia is found, a little later the same patch may be sensifacient, or even hyperæsthetic or hyperalgesic. This may partly be accounted for by summation of stimulus, or by the variability in the irritability and conductibility of the systems of spinal sensory neurons, but still more often to the subjective attitude of the individual—the state of consciousness which is especially related to the physiological activity of the cortex cerebri.

In tabes with insanity, we can therefore understand how acute the suffering of a patient is, when he concentrates the

consciousness of an unsound, but still active, mind upon the pains and tortures, which he believes enemies and unseen agencies are working upon him. The effect on the mind is reflected in the physiognomy, which portrays misery and dejection.

In tabo-paralysis, in the early stages, there may be an intensification of the pains and sufferings by the subjective attitude of the individual towards the effects produced by the irritation and degeneration of the sensory, somatic, and visceral neurons; and as we have said before, and given numerous illustrations thereof, such may cause pseudo-hallucinations, illusions and delusions.

In the later stages of tabo-paralysis, as, indeed, in general paralysis, when the dementia becomes pronounced, the patient suffers very little or no pains, nor does he feel pain when pricked with a needle. The stimulus may be the same, but the effect on consciousness is diminished or lost by the partial destruction of the cerebral cortex. This probably explains the fact that such patients may often suffer with very painful diseases without any complaint. The absence of pain associated with physical signs of tabes suggests, therefore, cortical degeneration.

COORDINATION.

Definition.—Coordination is the regulation and adjustment of the innervation currents flowing to correlated groups of muscles in such a way that the movement may be executed with precision in rate, force and direction, with the least expenditure of nervous and muscular energy. To attain perfect coordination even in the simplest movement entails a vast complexus of functionally correlated neurons in the cortex, mesencephalon, cerebellum and spinal cord.

The current of reciprocal innervation of correlated groups of muscles is dependent directly upon the outflow from correlated groups of spinal-motor neurons, with which the muscles are in direct anatomical connection.

The complexus of neurons which determines, controls, adjusts and regulates this mechanism of innervation is much more complicated than is generally supposed and taught.

Every day new experiments and observations show fresh paths indicating groups of neurons with special functions. We may consider these groups, however, under three headings:

- (1) Spinal, afferent and efferent.
- (2) Cerebellar and mesencephalic, afferent and efferent.
- (3) Cerebral, afferent and efferent.

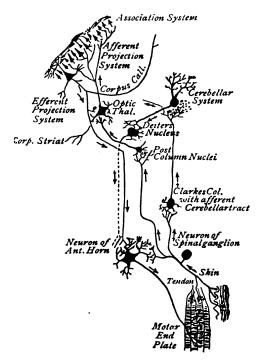


Fig. 48.

These are represented as the nervous circles in the accompanying diagram, which, however, is considerably simplified. In each of these nervous circles there are complex association systems, especially in the cerebral. The spinal intercalary are not represented, nor are the neurons which convey impulses by the optic nerves to the mesencephalon and cortex, nor those coming from the semi-circular canals to Deiter's nucleus.

In tabes no two cases are exactly alike as regards the clinical phenomena and morbid anatomy, but there is a

general resemblance in all, for of the 28 cases I have examined, the three sets of coarse fibres entering the posterior columns invariably showed simultaneous degeneration.

Reasons have already been advanced to show that these three sets of fibres, proceeding respectively to the spinal motor cells, to the cells of Clarke's column, and to the posterior column nuclei, represent sensory channels in the spinal, cerebellar, and cerebral nervous circles. There is good reason to believe that the bulk of the fibres forming the columns of Goll and Burdach come from the small muscles of the hands and feet, and this is supported by the fact, which Sherrington has shown, that one-third to one-half the fibres entering muscle are sensory, and terminate in muscle spindles. The proportional degeneration of fibres in the spinal, cerebellar, and cerebral afferent systems varies according to the roots affected; and the symptoms vary too.

It has been shown (1) that in every case in which there was marked ataxy there was degeneration of the plexus of fibres around the cells of Clarke's column. (2) That in Friedreich's disease there is marked ataxy, no loss of cutaneous sensibility, not very much hypotonus, but a marked degeneration of the fine plexus around the cells of Clarke's column, atrophy of the cells and of the ventral and dorsal cerebellar tracts. (3) Many cases of ataxy were met with in which there was little or no loss of cutaneous sensibility, but marked ataxy of the limbs. destruction of the coarse fibres in the lumbo-sacral region was usually much in excess of that of the fine fibre system of Lissauer's tract. We therefore conclude that the cerebellar afferent impulses play a most important part in coordination, and that the impressions coming from the deep structures are of more importance in coordination than those from the superficial structures.

We can now consider the mechanism by which the neuron complex represented in the diagram consciously and semi-automatically regulates and adjusts the innervation of muscles. We are conscious of the position of our limbs by the sensory impulses arriving at the seat of consciousness,

the cerebral cortex; and before a movement can be initiated ideation of the present position, followed by revival in consciousness of the position willed, precedes the outflow of impulses through the psycho-motor neurons. The accuracy of the kinæsthetic memory picture therefore determines the perfection of the adjustment and regulation of the efferent impulses concerned in the coordinate movement. anatomical substratum of cerebral coordination is therefore formed of all those neurons which convey sensory impulses from the periphery to the cortex, of the cortical perceptive neurons, and of the infinite combinations of association neurons lying between them and the psychomotor neurons, all of which give rise to the memory pattern which plays upon the terminals of the dendrons of appropriate groups of psycho-motor neurons, the efferent stimuli from which cause reciprocal innervation of correlated groups of spinal motor neurons, which in their turn preside over groups of synergic muscles.

With the progressive evolution of the brain in the zoo-logical scale, coordination in successive movements depends primarily more upon cortical and less upon spinal action. In man, coordination is primarily cerebral, even in semi-automatic processes such as walking; all spinal coordination has not, however, disappeared, for the most perfect example of subcortical coordinate reflex is still left to man in the prehension of a new-born infant, as shown by the fact that it can support the weight of its body when grasping a bar.

When the crura cerebri are divided in animals, viz., apes, decerebrate rigidity is produced; the cerebral nervous circle is no longer in operation, only the subcortical circles; and certain phenomena of great interest can be demonstrated. If the skin of the palm of the hand be stimulated by dipping in hot water, a reflex coordinate movement of flexion on the side stimulated, and extension on the opposite side takes place. The movement so initiated persists—cataleptoid state, due to persistence of reflex spinal and cerebellar impulses. When the posterior roots are cut, this cataleptoid condition immediately disappears; consequently the continuance of nnervation which led to the cataleptoid condition, whether

spinal or cerebellar, or both, depended upon incoming stimuli by the posterior roots (Sherrington).

As the stimulus employed in this experiment was only temporary it is more reasonable to suppose that the persistance of the stimulus, which produced the continuance of the movement initiated by the cutaneous excitation, was due to incoming stimulus from the deep structures being put in a state of increased tension in the new position which the limb assumed. There is every reason why it should thus persist. The neurons transmitting the incoming currents from the contracted muscles are anatomically and functionally correlated with the neurons which transmit the outgoing currents; and the subcortical, spinal, and cerebellar nervous circles which are transmitting the most innervation currents will prevail. Probably this effect is mainly of cerebellar origin, for Horsley and Löwenthal showed that stimulation of the cerebellum in a decerebrate animal produced contraction of biceps and active relaxation of triceps. uniform structure of the cerebellum suggests uniform function; probably it is an organ which functions as a whole. Hughlings Jackson has always considered it to be an organ which presides over continuing movement, and therefore static functions, as distinct from the cerebrum, which initiates successive movements.

Luciani's experiments show that total removal produces parasthenia, or defective force, paratonia, or defective tone, and astasia, or unsteadiness of contraction. The cerebellum is connected with the opposite cerebral cortex, and with the mesencephalon; it is probably to the severence of the connections with the latter, in ablation of the organ, that may be attributed the disturbances in gait and station.

In standing erect the cerebellum coordinates the innervation currents of the muscles of the limbs and trunk in such a way that the joints are fixed, and the line of the centre of gravity of the body passes through the knee- and ankle-joints. The weight of the body is therefore balanced upon the astragalus. This process is reflex and depends for its maintenance upon afferent impressions from the soles of the feet, and from the joints, muscles, and deep structures of the limbs and trunk, and from the semicircular canals.

In walking the cerebellum is reflexly coordinating the innervation currents to the muscles of the resting leg, while the cerebral cortex is coordinating the successive movements of the advancing leg in progression.

INCOORDINATION.

An ataxic, on closing his eyes, manifests instability of station—Romberg symptom. Normally, equable reflex spinal and cerebellar tonic contractions fix the joints of the lower limbs, but when the afferent impressions from the deep structures of the limbs and from the soles of the feet are cut off by degeneration of the lumbo-sacral posterior roots, the ataxic patient has to rely upon impressions from the semicircular canals and visual sensations for the maintenance of balance, by tonic contraction of opposing groups of muscles. When he closes his eyes, owing to the absence of guiding sensations he is unable to voluntarily reinforce by attention this tonic contraction; consequently, the source of compensation for maintaining equilibrium is removed, and swaying takes place, which, by the sensation from the semicircular canals, warns him of his danger of falling by the change in his state of consciousness of position, enabling him to recover himself by attention and an effort of the will. Romberg's symptom is an early phenomenon of tabes, and may exist without any cutaneous anæsthesia; it is due to the interruption of the subcortical reflex spinal and cerebellar circles by degeneration of those neurons with coarse fibres from deep structures, vide fig. 48.

Before proceeding to discuss the mechanism of cortical coordination, it is necessary to make some observations concerning the efferent systems of neurons from cortex to muscle, by which voluntary reciprocal innervation takes place.

The psycho-motor neurons lie in small groups in the cortex in a series corresponding to the segmental spinal series, except that the lowest occupy the top of the ascending frontal convolution; so that the longest axons arise from those cells which proceed to the lowest end of the cord (Sherrington.) These psycho-motor neurons become more

complex the higher we rise in the zoological scale; and the explanation is a proportional increase of combinations of association neurons which act directly upon an increased number of dendritic points of contact. Such cortical neurons are the effective agents of the will, regulating and adjusting by reciprocal innervation of spinal neurons the outgoing currents to muscles and the incoming currents connected with reflex muscular tonus. The diagram which has been used (fig. 48) is wrong in many respects; it represents, for simplicity, one psycho-motor neuron connected with one spinal motor neuron, whereas it is in indirect connection with many; otherwise the transection of the pyramids in the medulla should possess as many fibres as all the anterior roots put together.

Von Monakow is probably right in asserting that there is no direct connection between the psycho motor neurons and the spinal motor neurons, but that intercalary neurons exist. Schäfer has shown that the pyramidal fibres end at the base of the posterior horn and not in the anterior horns. Sherrington has, however, found degenerated fibres proceeding to the anterior horns. Von Monakow in his recent work gives the following paths of cortical impulses:—

- (1) A neuron, the axon of which enters the anterior horn and is brought into relation with groups of anterior horncells by means of an intervening intercalary neuron.
- (2) A neuron which ends in a terminal arborisation in the mescencephalon, and is brought into relation by an intercalary neuron with another neuron, the axon of which passes down the cord to end at the base of the posterior horn, and is thus brought into relationship with the terminal arborisation of the afferent reflex spinal neurons, which again influence the spinal motor neurons by an intervening intercalary neuron.

The experiments of Sherrington show that there is reciprocal innervation of functionally correlated groups of antagonist muscles, and we may assume that a group of psycho-motor neurons, when physiologically stimulated, initiates in the spinal gray matter innervation currents which augment the contraction in certain groups—for example,

flexors—and inhibit the reflex tonus in the antagonists—for example, extensors. The adjustment of this reciprocal innervation determines the range, the rate, and the time of cessation of the movement; but subsidiary synergic groups of muscles nearly always co-operate, and are especially necessary in determining and maintaining the required direction of movement. Two paths from the cortex which Von Monakow figures may therefore be the means of regulating this reciprocal innervation. Thus, if volition initiates a flexor movement, an impulse proceeds direct to the appropriate flexor-motor neurons, and simultaneously an impulse flows to the spinal reflex anastomosis of the correlated extensor group, the result being increased innervation of the flexor group and inhibition of the tonus in the correlated extensor group.

If, then, we are correct in assuming that there is a tract from the cortex which regulates and adjusts reflex tonus, we can understand that, as this reflex tonus is progressively abolished by the destruction of the posterior roots, there is a disturbance in the balance of reciprocal cortical innervation of the spinal neurons, and the resulting incoordination is partly due to uncontrolled over-action of one system of cortical psycho-motor neurons.

The physiological stimulus which excites, under the influence of the will, appropriate groups of psycho-motor neurons for the regulation and adjustment of this reciprocal spinal innervation of synergic muscles, takes place at the synapses of their dendrites, with immediately correlated association neurons. Voluntary reinforcement of this stimulus may take place by attention, which is a concentration of consciousness, so that there is a partial withdrawal of physiological activity from the cortex as a whole, with a corresponding concentration in a particular system of neurons comprising sensory terminals and correlated groups of association neurons, the result being a more vivid revival in consciousness of the perception which precedes the movement willed. There is a sense of effort attending this process, which we may assume is associated with a using up of potential.

After once the movement has been initiated, and repeated a number of times, the sense of effort becomes less and less, and it may be presumed that the nervous process is mainly subcortical after once the will has initiated the movement, and adjusted the necessary combinations of neurons for its performance.

In tabo-paralysis we have seen that a large proportion of the cases showed a degeneration of the crossed pyramidal tracts in the lumbo-sacral region, and we know that some of these cases showed very little ataxy in proportion to the degeneration, and a few exhibited less ataxy when the process of cortical degeneration occurred. The explanation may be that the long pyramidal fibres, having undergone decay, do not now overact and upset the balance between impulses going directly to the spinal motor neurons and those which influence reflex tonus.

No doubt the cortex is continually sending impulses down the spinal cord inhibiting reflex tonus; and this probably accounts for the fact that the knee-jerk may come back after cortical injury or disease, also for the existence of the knee-jerk on one side and its absence on the other. When the knee-jerk is present it means that some of the posterior roots of the lumbar enlargement are still present to conduct impulses, though not enough to allow of sufficient reflex tonus to give the knee-jerk; unless by a progressive decay, or acute degenerative changes, the cortical inhibitory influence is withdrawn; then (as in Westphal's experiments with strychnia), the knee-jerk is obtainable, because the afferent impressions now produce sufficient tonus. Jendrassik's method of reinforcement is probably explained in the same way, for by grasping the hands and pulling, attention is concentrated in the arm area of the cortex, and there is a withdrawal of physiological activity from the leg area, therefore cerebral inhibition.

The essential cause of locomotor ataxy is undoubtedly the degeneration of the posterior roots, but marked ataxy does not occur until there is some degeneration of the endogenous systems. This may be due to the fact that muscletonus may be reflexly induced by efferent impressions coming from spinal segments other than those which are directly correlated with sensory and motor structures in which the posterior roots are completely degenerated.

Further observations which I have made upon monkeys, in which the posterior roots have been divided by Professor Halliburton, have convinced me of two facts: (1) That a true ataxy of the upper limb cannot be produced by division of posterior roots, as Hering has asserted; for either the animal showed no incoordination of movement; or if, in cases when there was an insufficiency of roots divided to produce paralysis, there were jerky, incoordinate movements, they did not persist more than a few days; indeed, the animal which Hering quotes from Sherrington's and my observations, as having shown incoordination, which it did only for a few days, was the one which we, some months later, showed at the Berne Physiological Congress, with complete sensory paralysis.

Jules Soury, in an interesting summary of tabes, refers to the fact that Sherrington and I had shown sensory paralysis, but it was left to the sagacity of Hering to demonstrate the importance these experiments had upon the pathology of ataxy. This important relationship I had been fully aware of from the time that I made experimental sections of posterior roots in monkeys at the Brown Institution more than twelve years ago; but I have not yet satisfied myself that section of posterior roots in animals can produce a condition similar to locomotor ataxy in man. Any incoordination of movement which may follow section of roots is either soon compensated, or followed by complete loss of voluntary power. We cannot produce that systemic, elective, and unequal destruction of root fibres artificially. Ataxy is due, not only to loss of function from neuronic destruction, but to physiological over-action of structures, which normally act in opposition to those which are destroyed.

One of the earliest paralytic signs of tabes is a loss of tonus in the dorsal flexors of the foot, and foot drop while the patient is lying on his back in bed (see Case 46). This may be partially due to gravity and the weight of the bed clothes. If the patient is told to flex his hip to the uttermost, it will

be observed that the synergic dorsal flexion of the foot with hip and knee does not take place. By the aid of vision and attention he can produce the flexion, but it involves continuous attention, and even then it is not synergic, but follows the hip-flexion. In walking the principal movement for progression is flexion of the hip, but the range of movement would be limited unless there was an associated flexion of the knee and dorsal flexion of the foot.

Such a patient requires a stick or two sticks to widen his base of support, in order that he may so adjust his body that the line of the centre of gravity may fall within the basis of support, and that he may look at his feet and guide their movements. Thus, by cortical processes involving continuous attention he compensates for the failure of the normal kinæsthetic sensations which are associated with every successive movement, and which in all movements which habit or practice have made semi-automatic and periodic, become sub-conscious. Why, normally then, does the sense of a false movement immediately evoke consciousness of it? Because volition, having determined the complexus of neurons to be employed in initiating a movement precise in range, rate, and direction, the successive combinations of neurons are by associative memory revived in orderly sequence—the complexus of sensations in the last movement sufficing for the revival of the next in the series.

Ingoing and outgoing currents are flowing through the cortical neurones without any expenditure of potential. A false step occasions a break in the lines of least resistance, with discharge of potential at the new arrival platform of kinæsthetic impressions. In both locomotor ataxy and general paralysis, there is a failure in coordination; but the cause is different; in the former, the coarse reflex and semi-automatic adjustments are at fault; in the latter, it is the fine cortical adjustment. In every conscious movement, both fine and coarse adjustment are used—the smaller the muscles, the more delicate are the minute alterations of their tensions, the greater and more varied is the complexity of their combinations and adjustments. Complexity and multiplicity of movements determine the number of spinal motor neurons

innervating groups of muscles, likewise the number and complexity of the communities and systems of neurons which precisely adjust the outflow of spinal innervation cur-Take as examples the association rents to the muscles. of the hand and the eye, the ear, and the motor speech apparatus in the performance of the specially endowed human faculties, the communication of ideas by visual or verbal symbols, which brings directly into play successive combinations of systems of neurons too complex to analyse, but involving directly a large part of the cerebral cortex, the mesencephalon and spinal axis. However, the muscles which are especially innervated form but a very small fraction of the whole mass. The fine cerebral adjustment of coordination is continually and successively, by new combinations, infinite in number and variety, regulating the innervation currents of an infinite variety of spinal neurons, and thus adjusting the delicate tensions of correlated groups of minute muscles engaged in the expression of our thoughts and emotions. In general paralysis, the morbid process, early in the disease, strikes this fine adjustment in the cerebral cortex. The system of association neurons, which coordinate and associate the kinæsthetic impressions of near and distant related ideation centres with the psycho-motor neurons. are in a state of progressive decay, and although there may be no disease of the efferent path from the cortex in the early stage of the disease, yet, owing to defective and unequable stimulation of the cortical psycho-motor neurons, there is a failure in the precision of the reciprocal innervation of correlated groups of muscles used in verbal and written speech, manifest by tremor and incoordination. Some of the cases showed this very markedly, without proportional dementia and delusions. We must suppose that these were examples of functional selection in the morbid process.

THE PHYSIOGNOMY.

"There is no art to find the mind's construction in the face." One of the earliest signs of general paralysis is afforded by the expression, and we may recognise broadly

three types: (1) mask-like expression; (2) exaltation; (3) depression.

The first denotes a blank mind without active delusions of exaltation or depression, but often considerable dementia. Every emotion has its muscular concomitant in individual expression, and Darwin showed that so intimate was the relation between the two, that attention directed in such a way as to evoke the motor response of a particular emotion was accompanied by the correlated feeling.

In advanced dementia, the mind is a blank, there is absence of feeling, and consequently absence of motor response. Not only is there a blank expression in the face. but there is an expressionless hand. In those cases of the motor type, where there is lack of expression and marked speech affection without very much dementia, we may predict a more localised process (as in case 53) extensively destroying the neurons of association immediately connected with the psycho-motor neurons of the fronto-central regions. The conditions of exaltation and depression are, in all probability, partly due to neuronic destruction, partly to toxic and circulatory disturbances of the brain. The pathological process here acts like a magnifying glass, and control of what is passing in the mind no longer occurs. Like a muscular contracture in which one group of muscles continually overpowers the other, although the innervation current of the more powerful group is less than the normal, yet its effect is continuous and apparently greater, because the innervation of its reciprocal antagonist group is very much less than the normal.

The fixed ideas of exaltation or pain which we may consider as primary opposite emotional states, behave in the same way, and produce by the pathological process a magnified effect.

A patient not infrequently presents an expression of mental pain and dejection, but grandiose delusions and exaltation can be aroused in him by suggestion. The muscular concomitant is then shown by his facial expression; it immediately changes to one of exaltation, and the lustreless eye glistens when relating his wealth, strength, prowess or virility.

The emotions uncontrolled are reflected uncontrolled, and there is a failure in the reciprocal innervation of the muscles of expression owing to lack of reflex emotional tonus.

The subject of coordination is one of great interest, and I hope to deal more fully with its physiology and pathology in a future publication.

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326

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- * These works contain a very complete bibliography, and may be consulted for an analysis and summary of the conclusions arrived at by other workers.
- * * * I desire here to express my grateful obligations to my Colleagues at Charing Cross Hospital and to the Medical Superintendents and officers of the Asylums and Infirmaries for their kind assistance in calling my attention to the cases under their charge, and for permission to make observations and notes thereon.

AMENTIA. (IDIOCY AND IMBECILITY.)

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CONTENTS.

SECTION I.—The Causes of Amentia.—Introduction. Etiological Factors. General Considerations.

SECTION II.—The Classification and Varieties of Amentia.—Primary Amentia. Secondary Amentia. Amentia with Epilepsy. Amentia with Paralysis. Amentia with Insanity. Table of Classification.

SECTION III.—The Pathology of Amentia.—Notes on the Microscopical Examination of Twelve Cases. Tabulated Summary.

ILLUSTRATIONS.

REFERENCES.

SECTION I.—ETIOLOGY.

Introduction.

In this paper are given the results of an attempt which has been made to ascertain the true causes underlying conditions of imperfect mental development, varying from gross idiocy on the one hand, to the mildest forms of imbecility on the other. Much as has been written on the subject, it is yet one of such great importance that it is hoped the account of a further investigation may prove to be not without value.

The method which has been adopted is rather different to the usual one; most of the previous work has been based upon statistics compiled from case books, in which way a very large amount of material is available, but the details are, unfortunately, so incomplete that the conclusions drawn from them are often far from satisfactory. In the present instance, therefore, the chief object has been to ensure as complete and accurate particulars as possible of the ante-

cedents of every case by personal enquiries of the parents. In this way 150 satisfactory family histories have been obtained, in most cases embracing particulars of every member of the family for the last three generations, in a few the fourth is also included. In addition, the mental and physical states of the patients have also been carefully recorded, and noted from time to time for a period of nearly two years.

The enquiry was at first confined to the patients within the London County asylums, but it was soon found that such did not include all the different types; it was therefore extended, through the great kindness of the medical superintendents, to the special institutions at Darenth and Earlswood. In this way the writer had access to over 1,500 cases of various grades and types of amentia, and the complete histories of the 150 of these cases which have been obtained are thus representative of all the varieties of idiocy and imbecility which occur within the London area. This point is important, because the type of case varies much in the different institutions, and statistics which are confined to any one asylum cannot be considered as characteristic of the condition generally.

It will be instructive to give some idea as to the prevalence of these conditions. An accurate enumeration of the idiots and imbeciles in this or any other country is probably impossible, but for practical purposes it may be estimated that in most civilised countries there is, on the average, one such to every 500 or 600 healthy persons. According to the recent census, the population of England and Wales is 32,525,716, and we shall not be far wrong in putting down the number of cases of amentia existing at the present time as 50,000. Shuttleworth calculated that in the year 1895 there were roughly about 42,000. In France the returns a few years ago gave 36,000, but Bourneville, after a careful study of the subject, came to the conclusion that this was far from accurate, and that the number was at least 60,000. In the United States in 1890 the official return of the number of such cases was 95,000, and this was generally considered to be an under-estimate.

The above figures are sufficient to show the alarming extent to which idiocy and imbecility occur, and the importance of carefully paying attention to the causes to which they are due. There is, however, a still further interest attaching to the subject of arrested or imperfect mental development. It will be shown that in the larger number of these cases there is a blight upon the embryo from the very beginning, and that its complete and perfect development is impossible; also that this condition is more due to the seed than to the soil in which it grows, more due to the inherent condition of the germinal material than to the environment, important as the latter undoubtedly is. Idiocy indeed is, in most cases, the final expression of a tendency to degeneracy, which, first manifesting itself in deficient inhibitory power and instability of the nervous system, as is seen in hysteria and the like affections, passes, if unchecked, along its downward course, next revealing itself as epilepsy and various forms of insanity, to finally culminate in idiocy and the extinction of the family. Idiocy. therefore, is but the natural outcome of certain abnormal conditions of the germinal material, and in enquiring into its causes we are at the same time considering those factors which tend to bring about the general deterioration of the race.

Before entering upon a detailed consideration of these various causes, it is necessary to briefly allude to a few points in the development of the normal brain.

According to R. Boyd, the weight of the normal brain at birth is from 280-330 grams: during the first six months of life it increases to 600-680 grams, and at the age of one year it weighs about 750 grams; from this onward, growth proceeds somewhat more slowly until the weight of 1,300 grams for the male, and 1,150 grams for the female is attained at the age of 12 to 14 years. A further slight increase takes place up to the age of 20 years, but after that further mental development, consisting in the perfection of the judgment, deliberation, and power of inhibition, takes place more by the elaboration of the association systems by which the complexity of nervous pathways is increased than

by any marked increase in the weight of the brain. This elaboration is represented anatomically by a numerical increase in the fibres of the tangential systems (chiefly the outer line of Baillarger and the super and inter-radial fibres) and, according to the researches of Kæs, proceeds until the period of middle life is reached. After this age he states that a gradual diminution in these fibres takes place. They also undergo a marked atrophy in conditions of dementia, as I have myself verified by the microscopical examination of several such cases. The statement which has been made that the children of negro races in America are just as bright and capable of acquiring knowledge as the whites, up to the age of adolescence, but that they then rapidly fall behind, is very interesting in this connection.

From these facts it follows that arrest of the development of the brain and consequent weak-mindedness may take place at any period up to middle life; practically, however, the term amentia is restricted to those cases in which this happens before the age of 12 or 14 years, but, as will be shown afterwards, it is rare for actual arrest of mental growth to be produced so late even as this, and more cases occur during the time when the most rapid increase in weight is taking place, i.e., before 2 years of age; the number of cases having their origin after birth at all, however, is comparatively small, and an important point about these cases is that they are nearly always the result of a definite pathological lesion, which, in addition to the arrest of further growth, sooner or later brings about degeneration and consequent dementia. In the larger number of cases of amentia the development of the brain is not thus suddenly brought to a standstill, but the protoplasm set apart for the building up of the organ is from the very first incapable of proceeding to the perfect completion of the task, and a point is at length reached at which it can go no further; perhaps the term "imperfect" or "incomplete" development conveys a more accurate idea than "arrested" as the latter rather suggests an external influence.

It is most necessary to carefully distinguish between arrested or imperfect development (amentia), and degeneration

of already developed (it may be imperfectly) structures (dementia). Much confusion results from the extremely loose way in which the term "imbecile" is used; it should be restricted to the milder forms of amentia, but is very often wrongly applied to the milder forms of dementia following chronic insanity.

That the two conditions of amentia and dementia gradually pass into one another is shown by some cases of adolescent insanity. In some of these it can be shown that in addition to the nervous instability, with its tendency to degeneration and dementia, there is also an incomplete development, or a mild degree of amentia. In such a high-grade imbecile the advent of adolescence or some slight exciting factor throws an increased strain upon a nervous system whose physiological margin is already very low, and an attack of insanity is the result; this constantly tends to recur, and eventually the signs of dementia appear.

The two conditions may also occur simultaneously, as is strikingly shown in those imbeciles who develop general paralysis. Many of these cases have now been described, and such a condition was present in several of the writer's cases. Another excellent example is seen in the demential which supervenes in epileptic imbeciles.

Having now cleared the way by defining generally the nature of the process, we can pass to a detailed account of the causes to which this arrest of development can be traced. It must be carefully borne in mind that many of these assigned "causes" are at best only contributing factors, indeed that some of them may be merely accidental circumstances and have no connection whatever with the condition of the patient; in every instance we must guard against accepting as necessarily conclusive the explanation alleged by the parents. Our conception of these conditions will be more accurate if we look upon them as the result of several injurious influences, and not of any one individual factor.

These influences in their effects upon the developing embryo may be conveniently considered in the following stages:—

(A) Intrinsic.

The Condition of the Germinal Plasm.

Under this heading come the following Hereditary Influences:

- (1) Insanity, &c.
- (2) Alcoholism.
- (3) Consumption.
- (4) Syphilis.
- (5) Consanguinity.
- (6) Old age or dissimilar age of parents.

(B) Extrinsic.

The Environment.

(1) Abnormal conditions of the Mother during pregnancy. (a) Mental (worry, fright, shock, maternal BEFORE BIRTH. impressions, illegitimacy, &c.) (b) Physical (alcoholism, presence of disease, malnutrition.) (2) Injuries to the FŒTUS. Abnormalities of labour. (a) Protracted. (b) Precipitate. DURING BIRTH. (c) Instrumental. (d) Asphyxia neonatorum. Primogeniture. Premature birth. (1) Traumatic. (2) Teething convulsions, epilepsy, &c. AFTER BIRTH. (3) Infectious fevers, &c. (4) Sunstroke.

ETIOLOGICAL FACTORS.—(A) CAUSES INHERENT IN THE GERMINAL PLASM.

(HEREDITARY INFLUENCES.)

(1) Abnormalities of the Nervous System (Insanity, Epilepsy, &c.).

It will be convenient to divide abnormalities of the nervous system into two groups, as follows:-1. Insanity, weakmindedness, and epilepsy. 2. Various other conditions, such as tendency to cerebral hæmorrhages, paralyses, and definite neuroses not amounting to actual insanity.

The following table shows the prevalence of these conditions in the 150 families examined:—

Table 1.

Showing the extent to which Abnormal Conditions of the Nervous System were present.

		1.—Insanity, &c.	2.—Other abnormalities.	
On the Paternal side only		31.0 per cent.	9.5 per cent.	
On the Maternal side only		21.5 ,,	4.5 ,,	
On both sides	••	12.0	4.0 ,,	
Total		64.5 per cent.	18.0 per cent.	
Grand Total		82.5 pe	er cent.	

The next table shows the extent to which this heredity existed in the direct and collateral lines respectively:—

Table 2.

Occurrence of Insanity, &c., in the Direct and Collateral Lines.

	1.—Insanity, &c.	2.—Other abnormalities.	Totals.	
In the Direct line only	23.5 per cent.	14.7 per cent.	= 38.2 per cent.	
In the Collaterals only	17.0 ,,		= 17.0 ,,	
In both Direct & Collaterals	24.0 ,,	3.3 per cent.	= 27.3 ,,	
Total	64.5 per cent.	18.0 per cent.	= 82.5 per cent.	

From these tables it is therefore seen that there is a definite history of abnormality of the nervous system in the antecedents of no less than 124 cases, or 82.5 per cent. of those examined, and that in 64.5 per cent. this is either insanity or epilepsy, and that in 65.5 per cent. the abnormality occurs in the direct line.

These figures are certainly very much higher than any previously obtained, a fact which I think is chiefly to be attributed to the thorough and searching enquiry which, in every instance, has been made into the patient's antecedents.

Until the printed enquiry form which is now so largely in use is discontinued, and its place taken by a personal investigation into the family history, we cannot hope to obtain satisfactory and reliable details upon which to base statistics of causation. I am glad to say that such is now being done in some of the asylums. Dr. Taylor, the Medical Superintendent of Darenth Asylum, who has recently been making enquiries of this kind, tells me that he is becoming more and more convinced of the great importance of hereditary insanity, which he agrees with me in regarding as the chief factor in the production of idiocy.

It may be as well to state that in the tables given above only those families have been included in which the predisposition was definite and undeniable; indeed, to give some idea as to the extent to which this occurred, the following facts may be cited:—Out of the 150 families examined, there were (including the patients) 420 individuals mentally affected. In addition there were 121 individuals who, though sane, had some marked abnormality of the nervous system like those which have been described; thus giving, on the average, 3.6 persons affected in each family. The greatest number of affected persons in one family was ten. Several of these cases demonstrate the existence in some families of a very distinct tendency to vascular lesions of the nervous system, especially hæmorrhages.

With regard to the particular kind of insanity from which these antecedents suffered, the information is too incomplete to admit of any satisfactory deductions. It is obvious that although evidence of the existence of insanity might be forthcoming, in many cases no reliance could be placed upon the informant's account of its nature. In some instances, however, by searching through the case books of the asylums it has been possible to supply this, with the result that apparently the preceding insanity may be of any variety, and thus there are no grounds for thinking that one kind of mental disturbance more than another is liable in subsequent generations to be transformed into idiocy. Also the insanity in the parents need not necessarily have made its appearance before the birth of the patient.

Referring again for a moment to Table No. 1, it is seen that the injurious influence is transmitted somewhat more often through the male than the female side. Voisin, as a result of his researches, came to the opposite conclusion, and it is likely that if one had a sufficiently large series of cases there would be found to be no appreciable difference in this respect, and that the transmission occurred to about the same extent through the paternal and maternal sides.

The question as to whether hereditary transmission is more likely to take place from one sex to the opposite or to the same one—that is, from father to daughter and from mother to son, or vice versâ, is one which has been much discussed at different times. On such a matter pathological conditions like those now being considered, which can be readily traced, should throw some light. The following figures relate to this point:—

From this it appears that the transmission occurs to about an equal extent to the same and to the opposite sex, although male children are more likely to be affected.

(2) Alcoholism. Table 3. Showing the Number of Families in which Alcoholism occurred.

			With insane inheritance.	With other neuropathic inheritance.	Without any antecedent abnor- mality of nervous system.1
On one side only	••		26.0 per cent.	6.5 per cent.	4.5 per cent.
On both sides	••	••	4.5 ,,	1.5 ,,	3.5 ,,
Total	••	••	30.5 per cent.	8.0 per cent.	8.0 per cent.
Grand total of	Alcoho	lism		46 5 per cent.	

¹ In all these there was present either consumption in the ancestors, or some exciting cause in the environment of the patient.

Alcoholism is therefore present in the antecedents in 46.5 per cent. of cases, in the greater number in combination with insanity or other neuropathic conditions (38.5 per cent.), in a very considerable number associated with consumption, and in only two cases without either of these factors. In nearly all of those without neuropathic inheritance, however, there are other contributing causes, such as worry and illhealth of the mother during pregnancy, a severe attack of meningitis in the early months of life, &c. One way in which alcohol alone appears to be capable of occasionally producing idiocy will be alluded to under abnormal conditions of the mother during pregnancy. It will be seen that alcohol is rarely the sole cause of amentia, but on the other hand its importance as a contributing factor is very great; it will, perhaps, be better to draw attention to this after consumption has been considered.

Certain authors, particularly the French, have attached great importance to the fact of the parents, especially the father, being under the influence of alcohol at the moment of conception.

Quatrefages, Lucon, Morel, and, more recently, Bourneville have reported cases of idiocy which they considered due to this cause. The difficulty of obtaining reliable information of this kind is, of course, very great, on every possible occasion I tried to do so, and once thought that I had at last succeeded in getting definite confirmatory evidence. The informant was the mother of five children and she was perfectly certain that at the moment of conception of the patient, a pronounced idiot, the father was intoxicated. case seemed clear, until further enquiry elicited the fact that a similar condition existed with regard to each of her other children, and these were well developed and healthy in every Since then I have obtained similar evidence in several other instances, the father being intoxicated at the conception of the non-idiot as well as the idiot children, so that it cannot be said that my results afford any confirmation of this view. It is necessary to add that in each of the cases above mentioned careful enquiry revealed the presence of either insanity or consumption in addition to the alcoholic father; the probable reason why only one child was affected will be discussed later.

Of course, many cases of alcoholism must in themselves be considered an undoubted evidence of a neuropathic taint, probably of a defective power of inhibition; this is sufficiently shown by the way in which, in some instances, the "craving for drink" may be passed on from generation to generation.

(3) Consumption.

Under this heading are included in addition to pulmonary phthisis, caries of the spine, caseous glands, or any other undoubted tubercular lesion.

Table 4.

Showing the Number of Families in which Consumption occurred.

			With insane inheritance.	With other neuropathic inheritance.	Without any antecedent abnor- mality of nervous system.1
On one side only		••	16.0 per cent.	6.0 per cent.	5.5 per cent.
On both sides.	••	••	3.5 ,,	1.0 ,,	2.0 ,,
Total			19.5 per cent.	7.0 per cent.	7.5 per cent.
Grand Total of	Cons	umptic	n	34.0 per cent.	

That is to say that in every 100 families in which weak-minded children are born, in thirty-four there exists a marked tendency to consumption or other tubercular lesions, which in the majority is also accompanied by some abnormality of the nervous system (generally insanity). If it were possible these figures should, of course, be compared with similar ones regarding the mentally normal population, but as far as I am aware, none such exist. From such particulars as I have been able to gather from hospital patients, however, I am convinced that although there is a large amount of consumption amongst the antecedents of the mentally sound, it is to nothing like this extent. Addi-

^{&#}x27;In nine of these cases alcoholism was present in the ancestors in addition to the Phthisis; in the remaining two, although the Phthisis was strongly marked, I consider the amentia chiefly due to causes acting after birth, and these cases are, therefore, included in Table 7.

tional evidence as to the presence of this diathesis is furnished by the large number of idiots and imbeciles who succumb to one form or other of tuberculosis. Ireland estimates this number at fully two-thirds of all cases. Of course, in many or even most of them the general deficiency of mental and physical vigour may increase their susceptibility to the action of the tubercle bacillus, but one cannot doubt that a very large number of these patients evince a very marked predisposition to the disease apart from this.

With regard to the figures given under these two headings (alcohol and consumption) it must be clearly understood that the greatest possible care has been taken to include only those families in which their existence was well marked, as shown by there being at least three or four individuals affected in different generations of the family. Isolated examples have in no cases been counted unless occurring in the parents of the patient, and only then if very pronounced; otherwise the totals would have been very much greater than those given above.

From what has already been said it will have been remarked that these three factors, nervous abnormality, alcoholism and phthisis, very frequently occur together in the same family. Their great importance in the causation of not only idiocy and imbecility, but also many other morbid conditions of the nervous system, as well as that general deterioration in the mental and physical health which is expressed by the term "degeneracy," it is, I believe, impossible to over-estimate. This subject will be referred to again later; for the present it will be enough to point out by means of the following table the extent to which these injurious influences occur in the same family.

Table 5.

Showing the occurrence of Insanity, Alcoholism and Consumption in the same Family.

	Alcohol occurred in	58 cases.
	Consumption occurred in	40 ,,
which Insanity or other	Both Alcohol and Consumption	
abnormality of the nervous	occurred in	21 ,,
system was present	There was neither Alcohol nor Con-	
· · · · · · · · · · · · · · · · · · ·	sumption in	47 ,,

(4) Syphilis.

In investigating the relation of syphilis to idiocy and imbecility, it must be kept in mind that even if it is certainly known that the father has suffered from this disease, if in addition a train of miscarriages and other signs indicate that the mother has been infected, or, lastly, even if the patient himself bears the undoubted marks of syphilis, it must not therefore be concluded that this is the cause of the arrest of mental development. That a normal condition of the nervous system is compatible with the presence of the syphilitic poison is apparent from a careful study of the many cases of congenital syphilis which may be seen in the out-patient department of any large hospital, and also from the not inconsiderable number of persons of mature age one constantly meets, who are marked with the well-known signs of inherited syphilis. Thus, although in a certain percentage of cases of amentia there are indications of the presence of this poison, the above facts would rather lead one to think that in such there must also exist some other factor. To give actual figures, out of the 150 cases examined:

Syphilis was certain in 4 (or 2.5 per cent.), the patients themselves presenting undoubted marks of the disease.

Syphilis was possible in 5 (or 3 per cent.), a history of infection being obtained from the parents, although the patients showed no sign of the disease.

Syphilis could not have been present, therefore, in more than 5.5 per cent. of cases, and probably not in so many, and in all of these there were other factors. The chief of these other causes was antecedent insanity which occurred in five of the cases; in the remainder there was either phthisis or alcohol, or both.

The extent to which syphilis occurs amongst these patients is probably greater than amongst the mentally sound population, and its importance as a contributory factor must, I think, be admitted, but in view of the above figures, it seems to be only rarely that it can be looked upon as directly responsible for the patient's mental condition. Here, as elsewhere, the great importance of

hereditary neuropathic conditions is inevitably forced upon one, but where such exist I think the presence of syphilis is to be regarded as fraught with the gravest peril to the offspring. The syphilitic poison seems to have a special predilection for finding out the weak spot.

The question as to whether syphilis alone is capable of producing idiocy is a most important one. In addition to the cases of which I have complete histories, I have had opportunities of examining over 1,000 idiots and imbeciles of varying grades at Darenth Asylums, and, including all these cases, I have only been able to discover four, or at most five, presenting signs of syphilis in whom careful enquiries failed to also reveal the existence of some other factor, generally insanity.

There are two ways in which the syphilitic poison may act: in many instances it seems to have a powerful devitalising action upon all the tissues of the body, bringing about changes of a degenerative nature, in fact, a premature decay; such may, perhaps, be considered as the remote effects of the virus. It is conceivable that the germinal material will share in this general lowering of vitality, and that the resulting offspring may, in consequence, be incapable of attaining perfect development; given at the same time neuropathic tendencies in addition to the syphilis, and the arrest will be liable to be specially marked upon the nervous system. This is the action of syphilis which has been considered up to the present, and is the only action which can be looked upon as truly hereditary.

On the other hand, in certain stages of the disease the toxic effects are much more marked, and a child born during this period is much more likely to possess the characteristic syphilitic lesions; the child is, indeed, suffering from the actual effects of the virus. The fault is in the environment, and not in the germinal plasm, and this action of syphilis should really be placed under the abnormal conditions of the mother during pregnancy except that it is more convenient to allude to it in this place. In the *first* group the idiot is a primary one (vide Classification), the morbid anatomy consists in an arrested development of the nerve-cells, and the

condition is para-syphilitic. In the latter instance referred to, the patient comes into the secondary group, hereditary influences are not necessarily present, the morbid anatomy consists in one or other variety of "brain syphilis," to which the mental condition is secondary or symptomatic, and the condition is truly syphilitic.

As a rule, there is not much difficulty in distinguishing between these two groups, and my opinion is that, in cases of amentia, the latter is decidedly more frequent; the cases usually show well-marked signs of a gross lesion (meningitis, softening, sclerosis, hydrocephalus, &c.), and the mental condition becomes progressively worse; in fact, a condition of dementia soon supervenes.

And here it may be noted that the effects of syphilis, in producing degeneration, are much more pronounced than in causing arrest. Its importance in the causation of general paralysis has already been fully shown by many authors, and, in striking confirmation of this from the entirely opposite point of view, is the fact that out of the cases here described in which syphilis was undoubtedly present, no less than three have since developed general paralysis in addition to the idiocy, as verified by post-mortem examination.

It may be mentioned that even in regard to general paralysis occurring in adults evidence is accumulating to the effect that a neuropathic inheritance is also frequently present, and in the instances where this does not exist, it is still common to find that there has been some previous strain upon the nervous system, whereby the syphilitic poison has been enabled to get a hold.

Dr. G. A. Sutherland, in his able paper on "Mongolian Imbecility," suggested that syphilis might be the cause of this variety of mental arrest. I have obtained complete family histories of several such cases, and have also examined many patients, but have been quite unable to find any confirmation of this theory.

(5) Consanguinity.

It is the general opinion that the intermarriage of blood relations is fraught with considerable evil effects, both mental and physical, to the offspring. That this is the case in certain of the domesticated animals there seems to be no doubt, and practically all breeders of experience are unanimous that injury is almost certain to result from repeated "in-breeding." The effects upon the offspring are: the nervous system is rendered more excitable, and therefore more unstable, any existing constitutional defects are intensified, the size tends to decrease, and there is produced a predisposition to disease and an impairment of the reproductive functions. In other words, the result is a deterioration, and of exactly the same nature as that deterioration which takes place in the human being, the final expression of which is-idiocy. If, therefore, we can argue from the lower animals to man in this respect, and there is no reason for thinking that the laws governing reproduction are different in the two cases, consanguinity is undoubtedly harmful.

That is to say, consanguinity carried on to the same extent as inbreeding in animals would be undoubtedly harmful; but practically such does not occur, and the two cases are not quite on the same footing. It is likely that if a regular system of intermarrying took place, the results would be most disastrous, and such a practice could not be too strongly condemned. The question of consanguinity, however, reduces itself for practical purposes into the occasional marrying of first cousins, and it is chiefly from this point of view that it has to be looked at.

On the other hand, instances of repeated and systematic intermarrying, much more approaching to inbreeding in animals, are afforded by the Jews and the Quakers, also by the inhabitants of small out-of-the-way country districts and of inaccessible islands, cut off to a great extent from the rest of the world. It is an exceedingly difficult matter to obtain statistics of these peoples, and therefore to arrive at a definite conclusion on the subject. With regard to the Jews, however, there can be no doubt that as a race they are exceedingly neurotic and particularly prone to insanity and other diseases of the nervous system. It is impossible in this place to cite actual figures in support of this state-

ment, but much work on the subject has been done in different parts of Europe, and also lately in this country by Dr. C. F. Beadles, which fully endorses it. Still it must not be too readily assumed that consanguinity is necessarily responsible for all this. When one recalls the wretched conditions under which the Jews have been compelled to live for at least the past 2,000 years, from which, indeed, even now they are in many places not free, and when one thinks of the constant harrying to which they have all this time been subjected, it is not improbable that other factors than consanguinity may have left their mark upon the nervous system of the Jew.

As to the Quakers, I have been unable to obtain any actual figures, but I have been assured by several people who have an intimate knowledge of them, that the pure Quakers are rapidly becoming extinct, and that insanity is very rife amongst them.

Consanguinity to the degree in which it is practised by the Jews and Quakers must have injurious results, and if not the actual cause of deterioration must tend towards the propagation of defects which the introduction of new blood might dilute or even eradicate. In regard to the occasional marriage of first cousins, however, the case is different, and as a cause of idiocy I do not think this need be seriously thought of. Out of the 150 cases examined, such only occurred in seven instances, and in every one of these there were hereditary factors present, indeed in five of the cases there was well marked insanity. What is important to consider is the condition of the contracting persons: if these are in good health, and if their antecedents have been healthy and free from those diseases which have more particularly been found to give rise to deterioration in the descendents, then there is no objection to their marrying. I have known several instances of the marriage of first and second cousins without the slightest untoward result. From the practical point of view, therefore, the whole question turns upon this.

Dr. Gillet, of Paris, in a paper recently published, comes to the conclusion that consanguinity plays a most

important part in the production of idiocy, and at first sight his statistics seem to fully bear out his contention; but on a closer examination it is evident that he has completely ignored the question of the mental or physical condition of the ancestors, and simply taken note of the presence or absence of blood relationship.

To sum up, whilst systematic intermarrying is decidedly injurious, the occasional marrying of blood relations, if both persons are in themselves healthy, and if they come of healthy stock, is not so. It is not, however, a practice to be advocated, being the means by which any existing defect (which would probably be present on both sides) would be accentuated in the offspring.

(6) Old age of parents at birth of patient, or great dissimilarity in age of parents.

It seems necessary to briefly allude to these factors as cases of idiocy are still not infrequently ascribed to them. Amongst the families examined, there were four in which a great dissimilarity existed in the ages of the parents, in all of them it was the father who was the elder, the greatest disparity being thirty-two years; in all of these cases, however, there was also present either insanity or well-marked neuropathic diathesis, in three of them accompanied by alcoholism, so that it is probable that the actual influence of these causes is really infinitesimal. I have made enquiries into several other cases in which similar differences of age existed without any neuropathic predisposition, and in these the offspring were perfectly healthy.

(B) CAUSES EXTRINSIC TO THE GERMINAL PLASM. (Environment.)

The individual factors of the environment may most conveniently be considered in the three stages before, during, and after birth.

Those acting before birth are mostly referable to some abnormal mental or physical condition of the mother during

pregnancy, although an actual injury to the fœtus may also occur during this time.

During birth they chiefly relate to the various abnormalities attending labour, and in this place reference will also be made to primogeniture and premature birth. After birth the factors are either traumatic, toxic, or some similar morbid process, not yet fully understood.

Factors acting before Birth.

(1) Abnormal condition of the mother during pregnancy.—
The unnatural condition of the mother may be either a mental or physical one, the former embraces worry, sudden fright or shock, and the much discussed subject of maternal impressions; the bodily condition may be due to the presence of actual disease, or to a more general condition of imperfect health independent of any specific illness. The following table shows the extent to which these factors occurred in the cases examined:—

Table 6.

Abnormal Conditions of the Mother during Gestation.

<u>. </u>		Hereditary Influences	
		Present.	Absent.
	(a) Worry (illegitimacy of child, &c.)	3.5 per cent.	_
MENTAL.	(b) Sudden fright or shock	6.0 ,,	_
	(c) Maternal impression	1.5 ,,	
Physical.	(d) Presence of actual disease (alcoholism)		·6 per cent.
L HISICAL.	(e) General condition of ill-health (insufficiency of food, &c.)	10.0 ,,	_
		21.0 per cent.	·6 per cent
	Total	21.6 pe	er cent.

I have not mentioned insanity, consumption or alcoholism of long standing amongst these abnormal conditions of the mother, as they would rather tend to modify the germinal material and they have already been alluded to under hereditary influences.

It is apparent from the above that a history of one of these causes is obtained in a very considerable number of cases, but careful enquiry shows that in nearly every instance there are also hereditary influences bringing about a deterioration of the germinal plasm entirely independently of these factors of the environment. It must not, however, be concluded that therefore they have no importance, for although the embryonic material may be healthy, its power of development is still in a certain measure dependent upon the quantity and quality of the nourishment supplied to it by the mother, and a condition of actual disease or extreme prostration during pregnancy cannot but be injurious to the growing ovum. In the cases in which the hereditary neuropathic predisposition to idiocy is but slight these external factors, indeed, appear to have an extremely important contributory influence, and they may make all the difference between a development of the nervous system compatible with the needs of every day life and one of mental deficiency; as will afterwards be referred to, these and similar contributory influences explain why it occasionally happens that an idiot may be born into a family of which the other members show no obvious mental or physical deterioration.

The details which I have collected would tend to the view that in these cases the bodily condition of the mother is of more importance to the child than the mental state, and a condition of general physical prostration more often occurs than the presence of actual disease. In poorer people especially this malnutrition can often be directly traced to an insufficiency of food and fresh air during this critical time, due to the fact of the bread winner of the family being out of work; but apart from this it is perhaps scarcely to be wondered at that a large percentage of mothers in whom there is some hereditary taint should be very liable to evince mental or physical disturbances during pregnancy, which is a sufficiently trying period for women whose antecedents leave less to be desired.

It is probable that frequently recurring pregnancies may

also tend to bring about a diminished vitality of the mother and so contribute to the production of idiocy in cases where there exists a slight neuropathic predisposition; certainly the idiot child is often one of the later born in a large family, and especially is this so in the Mongolian type.

Without entering into the vexed question of maternal impressions, it can be said that both these and the sudden frights and shocks which are often alleged to be the cause of the patient's condition really have very little influence; so far I have been unable to discover a single case of this nature in which hereditary influences (commonly insanity) were not forthcoming upon a careful enquiry into the antecedents, so that whilst being unable to deny the possibility of idiocy resulting from such conditions, it can certainly be positively affirmed that such instances are exceedingly rare. It is not an uncommon event for a woman to give birth to a child during an attack of insanity, in fact a certain number of children are born every year actually within lunatic asylums, and I have elsewhere shown (vide Ref.) that their mental condition depends not upon the insanity of the mother, but upon the presence or absence of morbid heredity; if the father is healthy and free from neuropathic taint, and the insanity of the mother is only of a transitory nature, the conditions are not yet ripe for the production of idiocy, which is the last stage on the downward path.

There is one condition of the mother, however, which certainly does appear capable of producing idiocy in the absence of hereditary predisposition: this is excessive indulgence in alcohol. The following case appears to afford striking evidence to this effect: The father was a hard working industrious man, sound in body and mind, and coming of a healthy and long-lived family; he married the daughter of a small publican, apparently a healthy and happy girl, who used occasionally to serve behind the bar. Shortly after marriage this girl developed an insatiable craving for drink, all the money she could obtain by any pretence whatever, went in procuring it; later the ornaments and then the furniture of the house were pawned to feed her

desires; ten months after marriage she gave birth to a child—a hydrocephalic idiot, and according to the husband, she had scarcely known a sober moment during the preceding four or five months. Further enquiry showed that this woman's father was also a heavy drinker, but otherwise there was an entire absence of any neuropathic condition in the family. Of course it may be that the alcoholic taste of the mother was in itself evidence of the neuropathic diathesis, but I cannot help thinking that the child's condition was more largely due to an actual poisoning during its intrauterine existence, and this view seems to be supported by the subsequent history, for the next child that was born, after an interval of nearly two years, was perfectly normal, and is now a bright and intelligent boy of 8 years; by this time, however, the mother had recovered, and had lived a perfectly steady life during the whole of the pregnancy.

It is possible that occasionally other toxic conditions may bring about the same result, such, for instance, as the use of *Ecbolics*, and it is stated that in America the use of these drugs is responsible for a considerable number of cases of feeble-mindedness; syphilis may also act in the same way, as has already been mentioned; and some corroboration that the arrested development is actually due to the poison is furnished by the interesting series of experiments performed upon eggs by Féré; it must, however, be emphasised that cases of this nature are rare, and that in the large majority of idiots and imbeciles the presence of an abnormal condition of the mother during pregnancy has, at the most, only a contributing influence.

(2) Injury.—In a few cases the patient's condition is attributed to an injury received during its intra-uterine existence, but as these in no way differ from an injury after birth it will be better to refer to all the cases of trauma together.

Factors acting during Birth.

Abnormal labour.—It is generally considered that this is a very important and very frequent cause of idiocy. Beach

and Shuttleworth attribute no less than 17.5 per cent. of their cases to such a condition; but my own observations emphatically tend to show that the importance of this factor as a cause of amentia has been much over-estimated, and that the number of cases really due to it is very small.

The question is a most important one and beset with considerable difficulty; undoubtedly the extent to which abnormalities of labour will be found varies with the type of case examined. Thus I found such a condition to be much more frequent in the patients at Darenth Asylum than among those of the London County Asylums, the difference being due to the fact that cases in which there has been difficulty during birth are generally of the severest type owing to the arrest of development being complicated by an actual gross lesion, and they are, therefore, relegated to the special institutions.

Out of the 150 cases examined some abnormality during labour was present in twenty-seven, or 18 per cent. The different kinds of abnormality were:—Precipitate labour, 2 per cent.; difficult and protracted labour with asphyxia neonatorum, 14 per cent.; with instrumental delivery, 2 per cent. But out of these twenty-seven cases there was a definite history of hereditary predisposition in no less than twenty-four, and in twenty-one of these actual insanity existed. The three cases in which no predisposition existed were cases of asphyxia neonatorum; all are subject to epilepsy, to which the amentia is probably due.

One seems justified in concluding from the above facts that mere difficulty during birth, even if attended with asphyxia, can only be looked upon as the actual and sole cause of the idiocy in a very small number of instances, probably not more than 1.5 per cent.; the parents of the patients, and especially the mothers, are, it is true, usually quite satisfied with the explanation they offer; but I am convinced that if more careful enquiries be made into all such cases hereditary influences will be found to be present in a large number.

It is probably true that difficulties during childbirth are more frequent when the child is weakminded than when it is healthy; but may not this be, in a certain measure, due to the very fact that the child is of defective nervous and bodily development, since the process of parturition probably depends to a certain extent upon the movements of a healthy and vigorous child; and then again the mother who has an idiot for offspring is not unlikely herself to suffer from some deformity which presents more hindrance to labour than there would be in a perfectly healthy woman.

Whilst, therefore, not admitting to this factor a very important part in the production of idiocy, it must be allowed that it may yet have a very considerable influence in aggravating the tendency to (or actually present) imperfect development in the child; and certainly difficulties during labour, especially asphyxia, are in a great measure responsible for the gross brain lesions, with their resulting paralyses and convulsions, which occur in a large proportion of the more pronounced cases of amentia.

Little, in an important paper published in the year 1862, was the first in this country to draw attention to the mental and physical defects resulting from abnormalities of labour. He collected a series of sixty-three cases presenting various defects of this kind, the most common abnormality being the presence of asphyxia due to protracted delivery; but he himself says: "It is obvious that the great majority of stillborn infants whose lives are saved by the attendant accoucheur recover unharmed from that condition." A statement which has since been fully endorsed by many eminent obstetricians, and which is confirmed by everyday experience. It is indisputable that in a certain small percentage of cases in which asphyxia or other injurious factor is present some lesion of the brain results, causing a smaller or larger amount of paralysis-indeed, this condition is known as "Little's disease,"—and that of these cases affected with paralysis a small number may also show mental impairment. Out of the sixty-three cases collected by Little, however, there were only eleven in which the intellect suffered, two of these being actually idiotic, and the remaining nine suffering from various degrees of feeblemindedness, although in all his cases the patient was seen at an age at which mental impairment would have been noticed had it existed; indeed, the mental abilities of some of the other patients who were physically affected is described as being even beyond the average. Unfortunately, however, Little makes no mention of the family history in these cases, so that it is impossible to say whether there was or was not a neuropathic predisposition present in those children whose intellects suffered, and his paper, therefore, cannot be regarded as affording satisfactory evidence that amentia is at all a common result of abnormalities of labour.

If asphyxia leads to any evil result upon the nervous system, it does so by bringing about a vascular lesion (hæmorrhage or thrombosis). It has been said, however, that arrested mental growth may be caused by actual compression of the brain tissue, in other words, by a species of trauma, and it is in this way that the use of forceps has been held responsible for some cases; but when we consider the number of children who are daily delivered instrumentally, and the fact that the head of the child is subjected to great alterations of shape during normal labour without any subsequent ill effects, it is clear that the unaided action of any of these factors in the production of idiocy must be very small, more particularly since, in the large majority of the cases in which such does occur, hereditary predisposition is also present. Further, artificial compression of the child's head after birth has been practised by several races of people, and is even still in use in the Toulouse district of France without any apparent evil effects, and certainly without producing idiocy. Spiegelberg says that "the indentations and depressions which result in the cranial bones from pressure have a comparatively unimportant influence on the children." It is also recorded of Samuel Johnson that he "was born almost dead, and did not cry for some time."

Primogeniture.—It is said that first-born children are more liable to suffer from amentia than those born subsequently, and this is attributed partly to the more unstable mental condition of the mother during a first pregnancy, and partly to labour being more protracted in primiparæ

than in multiparæ. It has, however, already been seen that neither the mental state of the mother during gestation, nor the presence of difficulty during labour really have very much influence on the intellectual status of the child in the absence of neuropathic predisposition, so that it seems futile to seriously discuss the question of primogeniture. As a matter of fact, the statement that a large proportion of idiots are first-born children, is not beyond question. In the 150 families examined, there were altogether 1,248 children, or an average of eight to each family; the proportion of firstborns is, therefore, as one to eight. Out of the total number of patients, there were sixteen first-borns, or a proportion of one to nine; from which it does not appear that there is a much greater incidence upon first-born than upon other children; indeed, on the whole it seems to be more common for the idiot to be amongst the later-born, and very often he is actually the last child born alive in the family. In a family of degenerates, it is by no means unusual for the first one or two children to present no great departure from the normal; then come one or two who succumb to some ordinary ailment of childhood, from which a healthy child would probably have recovered, finally appears the idiot, and he is often followed by several children born dead. Of course, a sequence like this by no means invariably happens, but on the whole, in these degenerate families, there does certainly appear to be a tendency for each child to show more indications of mental and physical deterioration than the one which has preceded it.

Premature Birth.—7 per cent. of the patients were born prematurely, and in all of these hereditary predisposition was present. In cases where such is slight, it is possible that the alterations in nutrition brought about by the child being born prematurely, may act as a determining factor in the way already described, but this is the extent to which premature birth is capable of affecting the mental condition of the child.

Factors Acting after Birth.

The factors acting after birth which are said to produce, or to be concerned in the production of amentia embrace

trauma, epilepsy, teething convulsions, sunstroke, infectious diseases and similar morbid processes.

It is rare for any one of these, unaided, to give rise to amentia, and although the actual pathological process present may vary with the cause of its production, in by far the majority of cases, its influence in bringing about arrested development is purely contributory; in a few cases, however (5.5 per cent.), there is no hereditary predisposition, at all events none can be ascertained, and the resulting imbecility appears to be due to one of these factors; even in these, however, the immediate result of the lesion is nearly always epilepsy, and it is to the constant recurrence of severe fits, that the arrested mental growth is due.

The following table shows the extent to which these factors occurred:—

Table 7.

Showing the Factors acting After Birth.

					With neuropathic	Without neuropathic inheritance.		
					inheritance.	Accompanied by Epitepsy.	No Epilepsy	
(1)	Epilepsy (Idiopa	thic)		••	9 cases.	31 cases.	_	
(2) ′	Teething Convul	sions	••	• •	8 ,,	22 ,,	_	
(3)	Infectious Feve		l sir	nilar 	5 ,,	1³ case.	1º case.	
(4)	Trauma		••		5 ,,	15 ,,	_	
(5)	Sunstroke	••	••	••		16 ,,	1 ⁷ case.	
				-	27 cases or 18.0 %	8 cases or 5.0 %	2 cases or 1.5 %	
	Totals					24.5 %		

^{1. (}a) Both maternal and paternal grandfather died suddenly at an early age also well-marked phthisis on one side.

(b) Mild amentia resulting from epilepsy said to have been produced by overstudy at school.

- (c) Mild amentia resulting from epilepsy due to patient having been nearly drowned.
- 2. (a) Fits ceased after teething and reappeared at age of 6 years, since when they have persisted. A typical case of epilepsy with only slight amentia. The father used to be alcoholic, and his father appears to have been decidedly neurotic.

(b) Well-marked phthisis on the mother's side. A mild degree of amentia

accompanying epilepsy.

- 3. Fits following whooping-cough at the age of 6 months. Strongly marked phthisis on mother's side.
- 4. Slight amentia with gradually progressing dementia following enteric at age of eight years. No other cause discoverable.
- 5. Severe fall on to stone pavement at age of 4 years; unconscious for a long time—a week afterwards severe convulsions—very frequent and severe fits since. Pronounced amentia with much dementia. No other cause discoverable than fall.
- 6. Fits from 8 months, after sunstroke. Pronounced epileptic with considerable amentia and slight dementia. No other cause.
- 7. Sunstroke in India, age 8 years. No other cause. A condition of mild imbecility without epilepsy.
- (1) Epilepsy (Idiopathic).—The number of cases of amentia which are the result of epilepsy occurring in early life is by no means inconsiderable, being probably about 10 per cent. The subject will be again referred to under the next heading, but it may be stated here that although the condition is perhaps more analogous to dementia, the fact of the disease appearing before the age at which much mental growth has taken place necessarily produces an arrest of development as well—in other words a state of true secondary amentia. In by far the greater number of cases the epilepsy is brought about by hereditary influences, but the disease, having made its appearance, must be considered as one of the factors acting after birth.
- (2) Teething Convulsions.—Convulsions occurring during the first dentition are often alleged as the cause of idiocy, but when one considers that a very large number of children have severe fits at this time and yet show no subsequent mental impairment, it is obvious that this condition by itself cannot play a very important part in producing amentia. It is conceivable that in severe and prolonged convulsions a small hæmorrhage may take place and an actual lesion of the brain be produced, but the brain of a healthy child in most cases appears capable of recovering even from this.

Out of the ten cases in which the patients' condition was attributed to this factor there existed well marked hereditary influences (insanity or other abnormality of the nervous system) in eight, and it seems likely that in these the convulsions were but the manifestation of that same predisposition, in many of them being one of the earliest symptoms forthcoming of the presence of actual amentia; in a few, indeed, the mother had noticed that the child was not quite bright and like other children before the fits.

On the other hand, in several instances the teething convulsions are but the first indication of ordinary idiopathic epilepsy, and it is to the persistence of this that the mental arrest is due. Gowers states that "a considerable number of cases of epilepsy date from infantile convulsions," not that dentition is actually the cause of the epilepsy, but it supplies the necessary excitation to an already present predisposition. On the whole my observations would certainly appear to show that "eclampsic idiocy," that is, idiocy due solely to teething convulsions, in the absence of neuropathic inheritance is decidly rare, and that in the great majority of cases in which mental impairment is afterwards noticed the convulsions have either been the first symptom of that condition and not the cause, or else have been the first indication of the presence of idiopathic epilepsy; of course, if epilepsy make its appearance at such an early period in the child's life, and if it persist, arrest of intellectual development is almost certain to take place, followed later by dementia. Here, however, it is epilepsy that is the primary disorder, and the condition is one closely resembling epileptic dementia, with the addition that more or loss complete arrest has also been produced owing to the early onset of the attacks. (Vide "Amentia with Epilepsy," Section II.).

(3) Infectious Fevers, &c.—In certain acute infectious diseases occurring in early childhood such as scarlet fever, enteric, whooping cough, diphtheria, otitis, rhinitis, and also in some cases of meningitis, there are indications that a lesion of the central nervous system has been produced, probably owing to embolism, thrombosis or hæmorrhage. In another type of case the disease appears closely to resemble acute

anterior polio-myelitis and has been named by Strümpell "acute polio-encephalitis." As a result of these conditions various forms of paralyses frequently occur, and also convulsions, which at first have a localised character but afterwards become general and closely resemble idiopathic epilepsy. Retardation of mental development is a not uncommon accompaniment of such conditions; but cases in which they give rise to definite amentia in the absence of neuropathic predisposition or frequently recurring convulsive attacks are exceedingly rare; indeed, I have only met with one such case.

It is probable that the form of idiocy known as "infantile cerebral degeneration" or "amaurotic family idiocy" is really due to some form of toxine, although the pathology of this disease is still very obscure; the condition, however, is more one of a progressive degeneration than of amentia, although, of course, incidentally arrest of development also occurs.

(4) Trauma.—In a certain proportion of cases the patient's condition is attributed to a direct injury to the head at an early period of life, most commonly a fall. Sometimes the injury is said to have been inflicted upon the pregnant uterus, and at others compression of the head by forceps is held responsible.

In the larger number of cases of this description a careful enquiry into the nature of the alleged trauma is sufficient to show its triviality, and to demonstrate that it could have had no connection with the subsequent mental condition of the patient; indeed, in all these cases of *slight* injury which I have examined there exists a well-marked hereditary predisposition.

In the cases of severe injury, however, it occasionally happens that the most searching enquiry fails to reveal any factor whatever except the injury. This occurred in but one of the cases examined, in which the patient fell from a height of about three feet on to a stone pavement, alighting upon her head. Considering that in this case the family history is a fairly good one on both sides, and that the patient has eleven brothers and sisters all apparently in the

best of bodily and mental health, the connection between the injury and the resulting mental impairment appears to be clear. The patient was unconscious for a long time after the accident, and about a week later had a series of severe convulsions. These have continued on and off ever since, and at the present time are indistinguishable from ordinary epilepsy; scarcely a day passes without an attack, and some days there are two or three severe ones. In this case I think the condition is really more of the nature of traumatic epilepsy, and that the unexpanded intellect is due to the nerve storms which have been almost constantly present from the age of three years.

Between the two extreme degrees of injury above described there is a small number of cases in which the trauma seems to play the part of an exciting factor. It is rarely as severe as in the case just alluded to, but the condition of the child following the accident undoubtedly points to the presence of a lesion of the brain, generally of the nature of a hæmorrhage or laceration of brain tissue. In all the instances of this kind hereditary predisposition was present, and most probably it is owing to this that the development of the uninjured portion of the brain cannot take place sufficiently to compensate for that rendered useless by the trauma. Where epilepsy supervenes we probably have a constantly spreading pathological process against which no amount of compensation would avail. This question of compensation will be discussed more fully later; but it may here be remarked that head injuries of quite as severe a nature as those above referred to are by no means uncommon in children, and yet it is extremely rare for them to be followed by any permanent mental deterioration.

(5) Sunstroke.—In two instances the condition of the patient was ascribed to sunstroke, one occurring in India, and the other in this country during a very hot summer. In each case the child had previously seemed quite well, and the attack was immediately followed by a lengthy illness apparently of the nature of meningitis. The family history was good, and no other cause discoverable than the one alleged. It would therefore appear that in a small per-

centage of cases sunstroke may actually produce amentia. In one of the above there is only present a mild degree of imbecility, in the other the illness was almost immediately followed by severe convulsions, and the patient is now a typical epileptic, so that the arrested development is most likely the result of the fits. I have not yet had an opportunity of making a post-mortem examination of any similar case, but presumably the condition is one of meningoencephalitis or of vascular alterations similar to those brought about by toxic influences.

Rickets.—It is unnecessary to seriously consider the question of rickets as a cause of amentia, although some writers seem to think this disease can so act, and even speak of "rachitic idiocy." Undoubtedly rickets occurs in idiots and imbeciles, whether to a greater extent than amongst mentally healthy children I do not know; certainly, however, the association of rickets and amentia is not strikingly common, and even if it were, it would surely be more rational to consider the rickets the outcome of the general mental and bodily degeneracy than its cause.

Sex.—It is a somewhat singular fact that whilst the various forms of insanity are more frequent in the female than in the male sex, the reverse is the case with amentia. Upon this main point all writers are agreed, although the relative proportion existing has been variously stated. From German statistics Piper comes to the conclusion that there are two males to one female, but from my own observations upon cases in this country, as well as from statistics obtained from many asylums, the incidence on the male sex would not appear to be quite so high, and, speaking generally of all the varieties of amentia, I should say that the number is in the proportion of three males to two females.

The following tabulated form gives the ascertained factors to which it is considered the amentia is due in the cases investigated; it is therefore a very condensed summary of the preceding pages.

1.—1	HEREDITARY	INFLUENCES.

	(97 cases or)		Cases.	Per- centage.
(A) Insanity or Epilepsy	64.5 per cent.	Total neuropathic		
Other Abnormalities	(27 cases or	inheritance	124	82.5
of the Nervous System	18.0 per cent.			
In 58 cases or 38.5 p		sm was also present.		
In 40 ,, 26.5				
In 21 , 14·0	- · · · - · · · · · · · · · · · · · · ·	,,		
In 4 ,, 2.5	" syphilis	"		
(B) Both Phthisis and Alco	oholism (without	neuropathic inheri-		
tance)	··· `·· ··	· . .	9.	. 6.0
(C) Alcoholism			2.	. 1.5
Case I.—Both parer		other immoral, dis-		
<u> </u>	and criminal.	,		
Case II.—Father di		an epileptic with		
	ementia.	• •		
	Total of Prin	nary Amentia	135 .	. 90.0
II	-Extrinsic	CAUSES.		
(D) Before Birth. Abno	ormal condition	of mother during		
pregnancy		•	2	1.3
Case I.—Mother alc				
Case II.—Patient he				
		family history of		
phthisi	-			
-			3	2.0
(E) During Birth. Asphys In all cases epileptic			J	. 20
		tia is probably due.		
age, io	WHICH THE AMEN	ma is probably due.		
		vulsions 5 cases		
(F) After Birth. Trauma	• • • • •	1 ,, [10 .	6.7
Sunstrok	e	2 ,,	10 .	
(Toxic pro	cess	2 ,,)		
$\boldsymbol{\eta}_{\alpha}$	tal of Secondary	Amentia	15	10.0
10	see of Becondary	211100101111111111111111111111111111111	10 .	. 100

From this summary it will be seen that 90 per cent. are cases of primary amentia, being due to hereditary influences; whilst 10 per cent. are cases of secondary amentia, being due to extrinsic causes; but of these latter there are only 6 per cent. which may be looked upon as the result of unavoidable causes (see notes to Table 7), and in 5 per cent. of these the amentia was accompanied by, and probably due to, epileptic convulsions.

GENERAL CONSIDERATIONS.

Having now given an account of the various etiological factors which have come to light in the course of this investigation, and pointed out their importance or otherwise, as well as the extent to which they occur, it becomes necessary to consider the manner in which they act in producing amentia.

At the outset it is essential that we should carefully bear in mind what amentia really is. Generally speaking, its various grades are not to be looked upon as due to the presence of a definite disease or morbid process super-added to, or incident upon, a normal nervous system. There are, it is true, a small number of cases in which arrested mental development is the incidental accompaniment of some such pathological condition, the tendency being to dementia, and the entire process one of degeneration. The number of these cases, however, is small, and clinical experience and pathological research show that in by far the larger number of cases of amentia the prime condition is one of imperfect or incomplete development; in other words, a pronounced falling short of the standard normally attained. In the higher types of imbecility this imperfect development has fallen exclusively upon the central nervous system, and more particularly upon the higher portions of the brain, but in the more gross forms of idiocy many other parts of the organism are involved in the same incompleteness, as is amply shown by the general physical condition of such patients. Our conception of amentia, therefore, is not that of a definite disease, but of a developmental failure of either slight or pronounced degree.

It is in this respect that amentia differs from insanity. In most cases of the latter affection the condition may be regarded as one of premature degeneration of certain portions of the nervous system which have attained normal development, this degeneration in most instances being the result of hereditary influences, whilst in others it may be brought about by the action of "toxines"; but the gradual process of decay gives rise to various abnormal mental

states which we designate insanity, until finally more or less complete degeneration and dementia result.

We have now to study the manner in which this failure of development, which is the anatomical basis of amentia, is brought about. It has already been seen that the etiological factors are divisible into two groups, viz.:—I. Hereditary Influences (or factors in the environment of the ancestors); 2. External Influences (or factors in the environment of the patient); and these two groups must be considered separately.

Group I.—Hereditary Influences.

It would obviously be out of place to enter into any detailed discussion of the various theories which have been advanced regarding heredity; there are some points, however, which have a direct bearing upon the subject of amentia, and which must, therefore, be referred to. The views advanced by Weismann fully demonstrate the importance of the germ plasm in the transmission of qualities from parent to offspring, and in this respect are of great value; but it seems to me that everyday medical experience is very much at variance with his view that this germ plasm is not, or is only to a very small extent, influenced by the environment—that is by abnormal conditions of life, and more particularly by the presence of disease, which apparently is his contention. With regard to the transmission of acquired qualities which only affect the somatoplasm, the evidence is certainly negative, and as far as I am aware there are no recorded instances of the transmission of mutilations (even when performed systematically and upon many generations, as in the case of circumcision), or of the transmission of actual disease except where the embryo was directly affected by means of the placental blood. Amentia, however, does not come into this category, nor, for the matter of that. do such diseases as insanity or consumption; and it is not conceived that this is the way in which the sins of the fathers are visited upon the children even to the third and fourth generations. In the conditions just referred to it is not contended that the actual diseases are transmitted, but that, owing to their presence in the ascendant, the germ plasm

has become so modified that the resulting offspring is rendered peculiarly susceptible to the action of certain influences; in other words, there exists what is commonly called a "diathesis." Similarly in amentia: what is transmitted is germinal plasm of such a peculiarly modified nature that the development from it of a complete, perfect, and healthy human being is impossible. We cannot doubt that this peculiarity of germ plasm exists; what, then, is the cause?

The morbid conditions which have been described as occurring in the ancestors of these cases of amentia are present in such a large proportion of cases that it would surely be quite unreasonable to imagine that they bore no relation to the resulting imperfect development. It cannot be looked upon as a chance coincidence that out of 100 cases of amentia, abnormalities of the nervous system (chiefly insanity or epilepsy) should be present in the ancestors of more than eighty, and alcoholism and consumption in forty-seven and thirty-four respectively; and yet this would appear to be the contention of Weismann, if he believes that the germ plasm is practically incapable of modification by its environment.

I imagine that, at any rate, no one will deny that the tissues and organs of the body—the somatoplasm—may be altered in the individual by external influences, and particularly by the presence of disease, such, for instance, as consumption and alcoholism; or will do other than agree that the immunity which follows certain of the infectious diseases is the result of some similar change. present purpose the diseases which affect the human body may be divided into two kinds; on the one hand are those in which the morbid process is practically confined to one organ and is chiefly local in its effects, or if general is of only a transitory nature; such diseases may be compared to mutilations and abnormalities of the somatoplasm, and their effect on the germ plasm is probably nil. On the other hand, however, there are certain diseases and morbid influences which bring about a profound change in many, if not all, of the organs and tissues of the body, either, it may

be, by a direct poisonous action, or by causing pronounced alterations of nutrition. Among this class are consumption, syphilis, and alcoholism. Whether the action of such factors is directly toxic in nature, or whether they interfere with the general nutrition of the body, is no great matter; daily clinical experience and post-mortem examination amply show that there is present a great and almost universal pathological change. Is it conceivable that amid all this change the germinal plasm should remain entirely unaffected?

It is on this point that I believe the experience of the physician who has daily opportunities of observing the differences which exist between the descendants of such diseased individuals and those of healthy ones is strikingly opposed to this hypothesis of Weismann, and one sees so many instances in daily medical practice of a weakly and puny offspring of these patients, who seems "born to trouble as the sparks fly upward," that it is impossible to avoid the conclusion that some modification of the germ plasm has taken place. Further, the important work of Fournier in connection with syphilis gives additional support to such a view. He has fully shown by many cases that the syphilitic virus is capable of producing many and varied pathological changes in the offspring of the affected parent. I do not refer to those which are the result of a direct infection through the placental blood, but to the "parasyphilitic" conditions, which seem to be only capable of explanation on the view that some alteration in the germ plasm has been brought about.

For my own part I do not see any other reasonable construction which can be put upon the figures given in the preceding tables than that the presence of these morbid conditions in the ancestors has so modified the germ plasm, either by direct toxic action or by interfering with its nutrition and vitality, that it is incapable of producing a perfectly developed being; indeed, I would go even further and say that the subject of amentia and the data which have been collected in this investigation afford very definite evidence that such really does take place; and that it is by reason of such modifications in an unfavourable direction

that disease is perpetuated, and it is owing to the inherent capabilities of the germ plasm for such modification that evolution is a fact and the future advancement of the race a possibility. Let us, then, away with this fatalism, and remember that each individual is a potent factor which must operate either for the advancement or the retrogression of the generations to come. An idiot is no freak of Nature or haphazard gift of Providence; in Nature there are no freaks, and idiocy and imbecility are but the outcome of the action of definite laws.

It has been already stated that amentia is a condition of imperfect development, it is also the final expression of a progressive neuropathic degeneration, and in many of the histories which I have collected it is possible to trace this downward march. From family histories taken of cases in the different grades of this neuropathic degeneration it is found that well-marked abnormalities of the nervous system in the ancestors exist to a far greater extent in amentia than in any of the other grades; next to this they occur most frequently in insanity and epilepsy (especially the more severe forms which tend to result in rapid dementia); and they are relatively infrequent in the milder forms of epilepsy, hysteria, and neuralgia. In a very large number of the latter affections, however, there is present a history of alcoholism or consumption, very often both, and I believe that these two conditions play a most important part in the origination of the neuropathic diathesis. Idiocy, then, is the final expression of a neuropathic tendency, the earliest manifestations of which are hysteria, chronic neuralgia, and the minor forms of epilepsy; in the next stage appear more severe epilepsy, (usually dating from an earlier period of life) insanity, and tendency to early dementia; and last of all idiocy, with obvious evidences of physical degeneracy and very often extinction of the family. The most reasonable view would seem to be that the germinal plasm shares in the general bodily deterioration which results from the harmful conditions mentioned above, and that, therefore, the offspring to which it gives rise is rendered unstable and of diminished vital energy in the most delicate and newly acquired portion

of its complex organisation—the nervous system—in other words, a neuropath has been created; should such a person marry another with similar neuropathic tendencies an aggravation of the condition will be the result in the next generation, and epilepsy and actual insanity will probably be present. If a repetition of the same process occurs marked degeneracy will be present in the third generation with a strong probability that one or more members will be actual idiots or imbeciles.

Of course, there are probably other factors besides alcoholism and consumption which contribute to this first departure from the normal, but which, being less marked, are not so capable of recognition. It is indeed more than likely that many of the conditions of life at the present day, the struggle for place or for mere existence, with its accompanying wear and tear and nervous strain, and often insufficiency of food and fresh air, contribute largely not only to the deterioration of our manners but also of our nervous systems, and tend to initiate that neuropathic diathesis, that slight departure from the nervous normal, which, if unchecked, will pass on to epilepsy, to insanity, and finally to idiocy.

It is not, of course, intended that the three grades of mental affection above described are necessarily restricted to three consecutive generations. All the varieties may, and frequently do, exist among the members of one generation, and it even occasionally happens that idiocy of the grossest type results from the presence of alcoholism and consumption in the parents without any previous abnormality of the nervous system whatever. The fact, however, that actual abnormalities of the nervous system are present in the antecedents of 82 per cent. of these cases is proof that such does not commonly happen, and the outline which has just been given may be taken as a general view of the successive steps in the production of idiocy. To give some further idea of this, it may be useful to state a few facts regarding the brothers and sisters of the patients of whom these histories were taken. In this respect the following table is instructive.

Table 8.

Showing particulars of the Brothers and Sisters of 150 Idiots and Imbeciles.

n the 150 families			
Number of Children Born			
Alive 1,099 Dead 170		1,2	
	Unsatisfactory.	Satisfactory.	
Number now Living			
(A) Healthy	_	456	
P_{N} (Delicate 83)	328		
(Mentally affected 245)			
Number DEAD			
Under 1 year 138 \	į į		
3 107	315		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	515	_	
Over 20 ,, 25)			
	643	456	
	Unsatisfactory total.	Satisfactor total.	
	1,099		

Thus the total number of children born alive in these 150 families is 1,099, or on an average 7.3 born alive in each. The average number in each healthy family in this country is 4. The great difference in the number born is therefore worthy of note, as is also the large proportion of children born dead. Out of this total of 1,099, at the present time 784 are living, 456 of whom are said to be in good health, 83 delicate, and 245 mentally affected. A large proportion, therefore, of the brothers and sisters of these patients possess such a diminished vitality that they are unable to survive the ordinary illnesses of childhood, and many of those still living are amongst the most unprofitable members of society, possessing well-marked stigmata of degeneracy or being idiots or imbeciles. With regard to those described as "healthy," it must be remembered that

this is always the parent's valuation, and therefore the most favourable that can be taken; as a matter of fact, my own experience is that a large proportion of them are far removed from the average standard of mental or physical health, being undersized, lacking in the faculty of initiation, and often coming under the designation of "ne'er-do-weels."

There is, however, another type of case which at first sight appears to be quite distinct from the one just described, inasmuch as the patient may be the only one of the family showing any sign of deterioration, his brothers and sisters being well developed in body and mind. Similar hereditary influences exist here also, though not in such marked degree, and it is in these cases that they are mostly present on one side only. Evidently in these instances the condition cannot be attributed entirely to defects in the germinal plasm, as in that case other members of the family would also show signs of defective development; the question therefore arises as to why one alone should be affected.

It is under these circumstances that I believe the condition of the mother during gestation to be one of the most vital importance to the child; obviously it is a difficult matter to always obtain precise and accurate information on this point, but I have been much struck by the fact that it is just in these, what one might call sporadic cases of idiocy, that nearly all the instances of abnormal condition of the mother during pregnancy have occurred. These conditions have already been discussed, and it will be sufficient to note here that the one most frequently associated with the birth of an idiot is a general state of ill-health and exhaustion, in the poorer classes often accompanied by a deficiency of proper food. In several cases it has happened that during this time the father was out of work.

Apparently under these less pronounced conditions of hereditary predisposition, the germinal material, although to a certain extent vitiated, is still capable of proceeding to the perfect structural development of the embryo, provided no untoward circumstances intervene to further embarrass its growth, but should there happen at this time any deterioration in the health of the mother, whereby the blood supplying

the rapidly growing ovum is considerably modified in its nutritive qualities, then incomplete development is very likely to happen. As far as my experience goes, the physical condition of the mother is of far more importance than the mental state, except in the cases in which this may modify the physical condition.

In other instances the same result is attained by a somewhat different contributing, or as it may be termed, exciting factor. One fairly common such is premature birth; if by any unfortunate chance this should happen where there are already present predisposing factors, even if slight, the child is extremely likely to show some mental deterioration as compared with his brothers and sisters. In other cases prolonged labour, attended with more or less asphyxia, may act in the same manner; the temporary obstruction of the cerebral circulation need not be enough to give rise to any actual lesion, or in a healthy child even to produce any damage whatever, but in the present instance it is all that is required to interfere with the perfect development of the nerve cells, and some degree of weakmindedness is the result.

In the same way act some of the factors arising after birth, such as trauma, convulsions whilst teething, infectious fevers, meningitis, &c. It has already been seen that in the larger proportion of these cases, ancestral defects are present, and the exciting factor probably acts by causing a derangement of the cerebral circulation from which the nerve cells are unable to recover.

It is necessary to bear in mind that factors such as the above, are, however, as a rule, only accessory; the real origin of the condition lies in the defect of the germinal plasm; indeed, in many instances these accessory causes may themselves be the outcome of the same defect.

Group 2.—Causes Extrinsic to the Germinal Plasm. Environment.

It has been seen that, although in a considerable number of cases of amentia there are present injurious factors in the surroundings of the patient, yet the actual number directly attributable to these is very small. In the large majority there is a well-marked predisposition to imperfect development, and these accessory factors are to be looked upon as accidental complications, perhaps, it is true, occuring more frequently than amongst healthy children, since the very condition of imperfect development connotes an increased liability to secondary morbid processes.

In a small number of instances in which the hereditary predisposition is comparatively slight such factors may act in a determining or contributing manner, and in a still smaller number, probably altogether not more than 7 or 8 per cent., they appear to be capable of causing amentia unaided; but even in these the arrested mental development is usually brought about by the frequently recurring and severe epileptic fits to which the brain lesion gives rise, and they finally end in dementia.

It has been already mentioned that the brain of a healthy child appears capable of withstanding these external injurious factors to a very great extent; in fact, provided the patient be young enough, compensation takes place. evidence in support of such a view is as follows:-Within the brain up to 12 years of age there are present in all the deeper layers of the cortex a large number of neuro-. blasts, lying between and among the fully developed nervecells, and even in the brains of normal persons of middle age I have repeatedly found numbers of similar cells. It is very likely that such neuroblasts represent a potentiality of cerebral development which is never realised in the individual, and that in the normal brain the provisions of nature are far in excess of any call which is made upon them. Probably after youth the development of these neuroblasts into fully formed nerve-cells cannot take place, it is, however, upon their presence and the possibility of their being gradually brought into play that one bases hopes for the future intellectual expansion of the race. Broca, by comparing the skulls of 125 persons who lived in the twelfth century with those of 125 persons in the same rank of life who lived in the nineteenth century, found that the mean capacity of the latter had increased by two cubic inches.

In the healthy individual clinical experience constantly shows that lesions of the central nervous system can be recovered from, not by the regeneration of the injured nervous tissue, for all the evidence goes to prove that such does not take place, but apparently by the development and bringing into play of other cells to make up for those which have been destroyed. That such a compensation can and does take place in the motor nerve-cells cannot be denied, and this result seems to be achieved by the development of the neuroblasts which have just been described, as is strikingly shown by the following instance:—

In this case a lesion had occurred in the left Rolandic area, due (probably) to venous obstruction or hæmorrhage consequent on difficult birth; practically all the large motorcells in this area were destroyed, and the fourth cortical layer was represented by a very evident, clear, pale zone. In the corresponding region of the opposite hemisphere, however, these large motor-cells were present to a really extraordinary extent, they were all shapes and sizes, and more irregularly arranged than normally, but all had wellmarked Nissl-bodies and dendritic processes. It can hardly be doubted that the numerical increase was brought about by an attempt to compensate in some measure for the loss sustained by the opposite hemisphere. Such a view was further supported by the clinical condition of the patient, for, in spite of the almost complete annihilation of the large motor-cells of the left side, there was very little paralysis, the patient could walk quite well, and could do useful work with the right hand, the finer movements alone being somewhat defective. In this case the patient's family history was entirely free from any neuropathic taint. There are many similar cases of paralysis occurring during early life in which almost complete recovery has taken place.

If compensation of this nature can take place amongst the motor cells it is not unjustifiable to think that the same may happen in those whose function is higher, provided only that the demand be made at a sufficiently early period of life. It may be, of course, that in cases of cerebral lesions the resulting mental condition is dependent upon the *site* of the lesion, and further pathological research is still desirable in this direction; there have been recorded numerous cases of porencephaly, cysts, &c., however, in which the patient had attained normal mental development, and Schroeder van der Kolk mentions a number of instances tending to show that a large portion of one hemisphere may be diseased, and yet the patient show no mental impairment; clinical experience also rather tends to the view that the question of idiocy or non-idiocy in these cases cannot be entirely explained by any difference in the site of the lesion.

It is not unreasonable to suppose that in the descendants of neuropaths or otherwise degenerate stock the vitality of the nerve-cells or neuroblasts is so diminished that they are incapable of responding to any extra demand which may be made upon them, in fact (as is shown by the microscopical examination of cases of primary idiocy) a large number of the cells which normally come into action are not sufficiently developed for ordinary requirements, and on the whole I am inclined to think that in those instances in which a lesion of the brain has been produced by one of these external morbid factors, the subsequent mental condition is chiefly a question of the presence or absence of hereditary influence and of the capabilities of the neuroblasts of compensating for the lesion.

It has been seen then, that not only idiocy and imbecility, but also insanity, epilepsy and a large number of neuroses, are, in the majority of instances, the result of ancestral defects. It obviously follows that any attempt to lessen their serious prevalence must be chiefly directed towards the morbid states to which they owe their origin. The importance of grappling with Consumption, Alcoholism and defective Hygienic Conditions generally cannot be too strongly urged, and it is to measures for the amelioration of these that we must chiefly look for any appreciable improvement in the mental health of future generations; at present the general public hardly realises to the full the injurious

effects of these conditions upon the *individual* and cannot be said to have any real conception of their consequences upon *posterity*.

To refer more particularly to amentia, I have no hesitation in saying that in the large majority of the cases existing at the present time we can hope for little improvement of any real value. It is true that a certain number of patients of the higher grades may be taught various kinds of handicraft and in this way they may become partially self-supporting, and thus less of a burden to their friends, to the State, and also to themselves; but for much beyond this we cannot hope, and it cannot be too clearly understood that those patients are defective from the very beginning, and that no process of education or training will supply such defect and enable them to take a place in the world and compete with normally developed persons. In the present day it is even questionable if such methods of so-called education are not carried a little too far, the training of imbeciles is in danger of becoming a popular fad, and there is a tendency to allow it to run in lines which are altogether unsuited to the requirements and capabilities of these patients.

With regard to the lower grades, it may at once be said that the great bulk of them are hopeless, and, to speak quite plainly, the great majority of the idiots and imbeciles at present existing should have been treated three generations back; it is decidedly questionable whether the many thousands of pounds which are annually spent in this country in the training of imbeciles would not be better expended in doing more towards the prevention of those injurious conditions above described, which, if unchecked, will assuredly give rise to a fresh crop of insanity, epilepsy, and idiocy in generations to come. Treatment must be preventive, it cannot be curative, and the sooner this is seen in regard to amentia the better it will be for the race, although, unfortunately, the doctrine of letting posterity take care of itself is one not easily eradicated from the human mind.

In addition to the above-mentioned diseases there is yet one other matter of the deepest importance in the production of amentia, and which has hitherto received very scant

attention: this is the question of marriage. Even apart from the subject of nervous degeneration, a large proportion of the disease which at present exists can be traced to unsuitable marriages. There are persons of whom it may be said almost with certainty that they will transmit disordered or enfeebled mental or physical conditions to their children; such should, of course, never marry; others again would probably only do so if married to persons of like tendencies. On the other hand, an existing taint, if slight, may by suitable marriage be much diminished in the next generation, and with still further selection may be finally eradicated. Although it generally happens that the child bears a greater resemblance to one parent than the other, it is nevertheless a mixture of both, and this is a natural means by which modifications and variations are brought about in the human The result of any union is, therefore, a step either in an upward or a downward direction.

This being so, the importance of the question of marriage cannot be too strongly advocated; it is far too often entered upon without any thought beyond the convenience or taste of the contracting parties, and, unfortunately, not always with even that amount of consideration; but sooner or later we shall be compelled to consider its effect upon future generations.

In some countries legislation towards this end has actually been adopted, the marriage of certain persons being prohibited, but what may be the practical effect of regulations of this kind I have so far been unable to gather; probably sufficient length of time has not yet elapsed for a clear idea to be gained. It is very unlikely that such a method of treatment will ever be legalised in this country however, and, even if it were, it is questionable if the results would be satisfactory; the relations of people cannot be influenced in this compulsory way, and it is more likely that beneficial results will be brought about by the education of public opinion as to the moral responsibilities attaching to the matter. The decrease of crime which has taken place during the last fifty years is probably far more due to the gradual cultivation of the moral sense, or at all events dread

of public opinion, than to the deterrent effects of punishment, and I think that it is in the same direction that we must hope for most good with regard to the responsibilities attaching to marriage. It will, of course, be long before we can expect the lower grades of society to be actuated by any such motives, but it is undoubtedly the solemn duty and privilege of the medical profession and of the Church to impress the seriousness of the subject on the general public. The Church has peculiar opportunities of rendering incalculable service to future generations in this respect by pointing out the important issues of the marriage tie, and the necessity of being influenced by other than selfish motives. The medical profession cannot too strongly warn their patients of the evils resulting from unsuitable marriages, and should be prepared to give more particular advice on this subject, and to decide on the suitability or otherwise of any particular case; such a decision must take carefully into account the antecedents of each person, and must be based upon an accurate knowledge of the factors which are injurious.

It is impossible here to enter more fully into this matter, and say what kinds of people should or should not be allowed to marry. Unfortunately such advice, even when asked for, is by no means invariably taken, but that it is occasionally sought is an indication that the public are beginning to awaken to a sense of their responsibility on the subject.

SECTION II.

THE CLASSIFICATION AND VARIETIES OF AMENTIA.

The classification of the varieties of amentia is by no means an easy matter; various methods have been adopted, some based upon the facial or cranial characteristics, others upon the presence of pathological lesions; others upon the degree of intelligence and capability of response to education; others, again, upon purely psychological grounds, such as the amount of attention; and yet others upon a partly pathological and partly etiological basis. That proposed by

Ireland is the one most used in this country; it is, however, open to several objections, since it brings together varieties which are really quite different, and separates others which should be in the same group; indeed, it is really little more than an enumeration of the various types of idiocy and imbecility, and can hardly be said to at all show the relationship which exists between the different forms.

Since many of the pathological conditions are more of the nature of accidental complications than the cause of the arrested mental development, and since similar pathological lesions may in this way complicate quite different varieties of amentia, a classification based upon *etiology* is probably more accurate than one based upon pathology.

Considered, therefore, from the standpoint of causation, we have already seen that all cases of amentia may be divided into two groups, viz., (1) those due to factors within the germ plasm itself as a result of ancestral defects (intrinsic); (2) those due to factors extraneous to the germ plasm (extrinsic). To the former group of amentia we may give the name Primary or Essential, to the latter Secondary or Accidental. It is, perhaps, necessary to say that these groups are not synonymous with the terms "congenital" and "acquired" when the latter are used (as they generally are) with reference to the existence of the condition before or after birth. According to such a division an idiot whose condition was due to an injury received during intrauterine life, or to some abnormal state of the mother during gestation (e.g., alcoholism), would be described as "congenital." whereas the condition is truly Secondary. On the other hand, Primary amentia (due to defects in the germinal plasm) may require the contributing action of some factor after birth to bring it into prominence (such as trauma or infectious fever), and then it would be called "acquired" under this classification.

The following brief outline of the chief features of these two groups of Primary and Secondary amentia will show that not only do they differ in their causation, but also in their pathology and symptomatology, and that such a division is therefore the most natural basis of classification.

Primary Amentia.

In this group the essential condition is one of imperfect development, although the actual capabilities of the individual members may vary within very wide limits; thus, on the one extreme we may have a being whose mental and physical states differ but slightly from the normal, to, on the other extreme, one who can scarcely be called human at all. To this group no less than 90 per cent. of all idiots and imbeciles belong. The mental condition in the worst cases is but part of the general failure of development of the whole organism, as is fully shown by the existence of the numerous physical defects and abnormalities which we call "stigmata of degeneracy." In the milder cases the higher mental functions alone may suffer.

The pathological condition will be more fully referred to under the next section; generally it is as follows: the brain may vary greatly in size and external appearances, but on the whole is smaller and more simply convoluted than normally; in the mildest cases our present means of microscopical examination may reveal little change, but in the more pronounced types the central nervous system is characterised by a paucity of cells which are badly-arranged and ill-developed, and by a diminution in the number of fibres composing the cerebral association systems. The horizontally coursing bundles of fibres known as the tangential layer, and the super- and inter-radial bundles are strikingly diminished when compared with the healthy brain. added to this imperfect growth there are frequently other gross abnormalities and more or less severe morbid processes (such as porencephalus, hydrocephalus, etc.), which may tend to bring about a degeneration of the already imperfectly developed nerve-structures, and so to produce dementia.

Amongst the cases of primary amentia there are five distinct varieties which may be distinguished by the presence of certain characteristics. The first is a simple arrested development, and this variety may therefore be called "simple" idiocy or imbecility. In the second and third (microcephalics and mongolians) the arrest has taken a more

particular form, and produced distinct types, the skull as a rule being smaller than normal. In the fourth and fifth (hydrocephalics and sclerotics) it is further complicated by the addition of pronounced pathological changes, and in these the skull is usually larger than normal. It must, however, be remarked that secondary morbid processes may accompany any of these varieties, but only in the two latter are they present to such an extent as to justify one in using them as a means of sub-classification. The following, therefore, are the Varieties of Primary Amentia:—

(1) Simple. (2) Microcephalic. (3) Mongolian. (4) Hydrocephalic. (5) Sclerotic.

Secondary Amentia.

In the cases comprising this group, the arrested mental development is purely accidental and symptomatic of some cerebral or other morbid process; such process may be the result of trauma, asphyxia neonatorum, sunstroke or some toxic condition, or of a disturbance of the thyroid gland, or of an imperfection of the organs of special sense. When a lesion of the brain is present, it not only arrests any further intellectual growth, but by its continued presence frequently also induces a degeneration in those neurones already partially developed, and so produces dementia. The cases in this group comprise at the most about 10 per cent. of all instances of idiocy and imbecility.

It has been seen that in a considerable number of these cases, the actual arrest is due to the frequent recurrence of epileptiform convulsions, and it must again be definitely stated that it is rare for one of these external causes (unaided by hereditary morbid influences) to give rise to amentia, except through the medium of epileptiform convulsions.

The pathological conditions underlying this group are various, and many of them yet imperfectly ascertained. The cases likewise differ greatly in their clinical appearances, chiefly with regard to the rapidity with which dementia supervenes. The group contains the following eight varieties, which may be divided into two classes:—

Varieties of Secondary Amentia.

```
Amentia due to

\begin{cases}
(A) & \begin{cases}
(1) & Epilepsy. \\
(2) & Encephalitis. \\
(3) & Hydrocephalus. \\
(4) & Trauma. \\
(5) & Infantile Cerebral Degeneration. \\
(6) & Juvenile General Paralysis. \\
(B) & \begin{cases}
(7) & A-thyroidism (Cretinism). \\
(8) & Sense deprivation. \end{cases}
\end{cases}
```

In Class (A) the process present is really more one of degeneration and dementia, and the arrest of development which necessarily takes place in the course of this is purely an incidental circumstance; as far as prognosis is concerned these cases are amongst the worst. In Class (B), there is, as a rule, no dementia, the condition being simply one of arrested intellectual development, and entirely dependent upon external causes. Want of space prevents any further description of these clinical varieties.

In the following Table of Classification I have attempted to arrange all the varieties of amentia on this plan; it is not suggested that such a scheme is anything like perfect, but it is claimed that it gives a clearer conception than is otherwise obtainable of the relations existing between the etiological factors, the pathological conditions and the clinical aspects in the many varieties of this disease.

In the first column a division is made into these two main groups, primary and secondary. In the next column are given the various etiological factors, arranged in three classes; in Class (A) they are hereditary influences only, and the amentia to which they give rise is purely primary; in Class (B) the factors are epilepsy, toxic, trauma and sunstroke; in the majority of instances these are simply contributory to those in Class (A), and the amentia is therefore primary; occasionally however, they may be the sole cause of the arrested mental development, which is then secondary. It will, therefore, be seen that the two groups overlap in this class. In Class (C), the factors are entirely extraneous, and are the sole cause of the amentia, which is therefore purely secondary.

In the next column are given the various pathological conditions present in these different classes; and in the last column is given a short general clinical description of the class, with an enumeration of the varieties of amentia which occur in it.

Practically the only difficulty which arises is in Class (B), in which the overlapping takes place, and here it is important to remember that whilst these factors may occasionally produce amentia unaided, they more commonly act as contributory influences to those in Class (A), having been necessary to bring about a failure of compensation, or at times being simply accidental complications. It will be seen that in these three classes, the importance of hereditary influences becomes less marked from above downwards, being the sole cause in (A), the chief factor in (B), and absent in (C).

Having allotted the case to its proper group, class and variety, it is then perfectly easy to specify the *degree* of mental ability by describing it as high, medium, or low grade. This is, indeed, absolutely essential for purposes of education and administration, but the attempt to arrange cases of amentia with regard to their intellectual capabilities only, without any reference to their place in the natural order of amentia, is entirely unscientific and misleading.

With regard to epileptic idiocy, this term should, strictly speaking, be confined to those cases in Class (B) in which the epilepsy is the cause of the condition; it is, however, very commonly applied to any and every case of amentia associated with epilepsy; this is apt to lead to much confusion, especially when we consider that about 50 per cent. of all idiots and imbeciles are subject to epileptic attacks of varying frequency and severity, and that nearly all the varieties may be so affected. I have already referred to the great prevalence of epilepsy in nearly all the varieties of secondary amentia; its incidence in the primary group is evident from the following particulars, which Dr. Beresford was good enough to collect for me, of the patients admitted to Darenth Asylum during the years 1898, 1899, and 1900:—

Clinical. Group. us degrees of amentia, ranging between gross idiocy, imbecility, and I slighter forms of mental weakness. ata of degeneracy are present, and, as a rule, education leads to more ess improvement in their mental condition. gross forms the patient is unable to speak, to wash, or even feed self, and has no idea of personal cleanliness; in the mildest forms condition is more one of mental instability, little change can be rved in the structure of the nerve-cells, but they seem incapable unctioning satisfactorily. Such high grade imbeciles are capable arning their own living, but are liable to acute outbreaks of nity, to which their first appearance in the asylum is frequently PRIMARY ertain proportion the condition is complicated by epilepsy or some due to causes n of paralysis INHERENT in the germinal llowing varieties occur:-plasm. 1. SIMPLE IDIOCY. 2. MICROCEPHALIC (also Scaphocephalic). 3. Mongolian.

- 4. HYDROCEPHALIC.
- 5. Sclerotic ("Hypertrophy of the brain").

s degrees of arrested mental development, as a rule not so pronced as in Class (A), and subsequently followed by progressive rioration and dementia. Education leads to little or no improvement. majority paralysis and epilepsy are present; the latter is frently at first Jacksonian in character, but afterwards becomes ral.

llowing varieties occur:--

1. EPILEPSY.

2. ENCEPHALITIS.

3. Hydrocephalus.

Amentia due to

- 4. TRAUMA. 5. Infantile Cerebral Degeneration.
- 6. JUVENILE GENERAL PARALYSIS.

SECONDARY OR ACCIDENTAL due to causes EXTRINSIC to the germinal plasm.

It must be remembered that in a juvenile general paralytic some ntia may have existed from birth, owing to causes in Class (A), the neration is super-added to this.

NDNESS, DEAF-MUTISM. &C., WITH AMENTIA (usually mild). Educaresults in great improvement.

pansion and development of the mind cannot take place owing to sensory pathways being closed, in this way communication with outside world (the chief means by which the human mind is loped) is cut off. Amentia actually due to such a condition is very ; but it is not unusual to find a primary idiot suffer from some ory defect, both conditions being the result of the same imperfect n development.

ETINISM. Thyroid treatment produces great improvement.

The state of the s

Variety of Amentia.					With Epilepsy.	Without Epilepsy.	
(1) Simple						87	100
(2) Microcephalic					• •	11	4
(3) Mongolian						-	6
(4) Hydrocephalic		••	••	••	••	13	6
						111	116
Total						29	27

The extreme rarity of fits in the mongolians is very singular and worthy of note; indeed, I have only seen two such patients who were the subjects of epilepsy.

Paralysis may also accompany several distinct varieties of amentia, and since it cannot be urged that this is ever the cause of the arrested mental development, being itself but a symptom, there is less justification for the term "paralytic idiocy" than for that of "epileptic idiocy"; it would be more logical to speak of such a variety of amentia with or without paralysis.

Such a term as "rachitic idiocy" should be abolished, since there is no reason for thinking that rickets is ever the cause of amentia.

There is one other condition which is such a frequent and important accompaniment of the higher grades of primary amentia that it must be briefly referred to: this is insanity. Such a complication is rarely seen in the special idiot institutions; it is, however, very common in the general asylums, and out of 200 cases of imbeciles whom I examined in these latter institutions, more than half either were or had been insane. The insanity may be of the emotional or ideational type, and in many cases hallucinations and delusions are present; recurrences are frequent and final dementia is common. Since I have elsewhere described these cases more fully (vide ref.), it is unnecessary to say more in this place.

SECTION III.

PATHOLOGY.—NOTES ON THE MICROSCOPICAL EXAMINATION OF TWELVE CASES OF AMENTIA.

Opportunities for the microscopical examination of suitable cases of amentia are by no means frequent, largely owing to the extreme solicitude with which these patients are now cared for in the various institutions set apart for their reception. I have, however, been able to make such an examination in twelve cases, and it seems worth while recording the results in this paper, more particularly as the cases embrace several varieties of the affection, and the conditions present have considerable bearing upon some points which have been alluded to in the etiological and clinical portions of this article.

At the outset it may be stated that the microscopical appearances fully coincide with the division into primary and secondary amentia which has been made, cases of primary amentia being characterised by evidence of imperfect or incomplete development, and those of secondary amentia by degenerative changes. In cases of primary amentia to which dementia becomes superadded (such as from general paralysis, epilepsy, &c.) these two conditions of imperfect development and degeneration co-exist; and in such it is by no means an easy matter to distinguish the imperfectly developed cell, as the degeneration present tends to mask that condition: a similar difficulty is experienced in making a clinical diagnosis in such cases, the original idiocy or imbecility often being only ascertainable after a careful enquiry into the attainments of the patient prior to the onset of the dementia; or, occasionally, by the presence of pronounced stigmata of degeneracy.

In the following pages an account will be given of the microscopical features of the nerve-cells, nerve-fibres, neuro-glia and vessels of these twelve cases, with some general remarks respecting the pathology of amentia. This will be followed by a brief abstract of each case, and a summary showing the important points in tabular form.

Primary Amentia.

The skull.—In most of the cases of primary amentia examined this is thicker and denser than normal, the diploë being practically non-existent. This condition of the skull was formerly considered to be the cause of the imperfect mental development, and the view that microcephalic idiocy is brought about by premature synostosis of the cranium is not even yet obsolete. This, however, is clearly to put the cart before the horse, and such a view cannot logically be maintained. It may be stated that numerous cases of microcephaly have now been recorded in which the sutures were not closed, and in the instances in which they are it is probably due to the very fact that the brain has ceased to grow. That the increased thickness of the skull is simply compensatory for the small size of the brain is also shown by the fact that it is chiefly the inner table which is involved, and that if one hemisphere be less developed than the other, the corresponding half of the skull (chiefly the inner table) becomes proportionately increased in thickness. Further. in some cases of hydrocephalus, or enlargement of the brain due to other causes, the skull increases in size and becomes very much thinner, at times, indeed, being insufficient to cover the encephalon but for the formation of Wormian One cannot help thinking, therefore, that the general shape and dimensions of the skull are chiefly influenced by, and closely follow, those of the contained cerebral matter.

The membranes.—In the cases in which dementia has supervened upon the amentia the membranes are found to be more or less thickened, the dura mater sometimes being firmly attached to the vertex of the skull and the pia-arachnoid being opaque and stripping with unusual readiness from the surface of the brain, in the widened sulci of which exists considerable excess of cerebro-spinal fluid. These conditions, however, are those of dementia and not of amentia, in the ordinary cases of which, where no pathological condition or gross abnormality of development is present (such as porencephaly, cysts, &c.), the membranes are normal.

Brain.—In the milder types of imbecility the naked eye examination of the brain frequently reveals but little departure from the normal; the convolutions may be less complex than usual, but in other respects there is nothing to attract attention, and the size and weight may be quite equal to the average.

On the other hand, in the pronounced forms of idiocy the naked eye examination of the brain usually affords ample evidence of that condition, the organ being small, imperfectly and irregularly convoluted, with occasionally a greatly altered consistence. The hemispheres may be unequal in size, sometimes markedly so, and various forms of local agencies and other abnormalities may be present; in other cases definite morbid lesions also exist, such as hydrocephalus, localised softening, &c.

It is unnecessary in this place to deal more particularly with the many abnormalities which may be met with in the idiot's brain, beyond remarking that they may all be referred to one of two groups, viz. (1) those due to errors of development, (2) those due to secondary morbid processes. The former are but a further and more gross expression of the incomplete development, which will presently be described as existing in the nerve-cells; the latter conditions appear especially prone to affect the imperfectly developed brain. In my opinion, it is very rarely that any of these conditions can be considered as the cause of the mental deficiency (although—generally by giving rise to epilepsy they may in a few instances produce dementia with some incidental arrest of mental development), since a difference of several hundred grams may exist between the two hemispheres of the brain, owing to porencephaly, cysts, &c., with very little or even no appreciable mental impairment. It is, of course, possible that in a small number of cases mental deficiency may be brought about by one of these lesions occurring in early life, and depriving the brain of a large number of cells, if at the same time the developmental capacity of the remaining cells is so limited (by inherent defects of the germinal plasm) that compensation cannot take place in the manner described under "Etiology."

This, however, is due to the condition of the nerve-cells, and therefore, strictly speaking, these morbid conditions do not, as a rule, belong to the pathology of amentia, but are more of the nature of complications. Incidentally it may be noticed that in cases of focal lesions of the brain occurring at an early age there is an arrest in the development of those portions of the nervous system whose function is correlated to the diseased part.

Nerve-cells.—In all the cases examined there are important alterations in the condition of the nerve-cells, and the amount of change discoverable under the microscope bears a distinct relation to the degree of mental deficiency noticed in the patient during life. The abnormalities of the nerve-cells are the following:—(1) Numerical deficiency; (2) irregularity in arrangement; (3) imperfect development of individual cells.

- (1) Numerical deficiency.—Although an actual enumeration of the nerve-cells present in these cases cannot be made, I am convinced, from the careful examination of a large number of sections, that the cells composing the gray matter of the cerebral cortex are decidedly fewer than in the normal brain. In some cases, indeed, this paucity of cells is so marked that it brings about a decrease in the thickness of the cortical gray matter which is obvious to the naked eye. Further, although the cells of all the layers appear to be fewer than normal, it appears to be the small and medium-sized pyramidal cells which are most diminished in number.
- (2) Irregularity in arrangement.—Notwithstanding the statement of Hammarberg, I certainly think that irregularity in the arrangement of the nerve-cells of the cerebral cortex is far more commonly met with in the brains of the mentally defective than in those of normal intelligence. The condition was present in all the cases examined, the pyramidal cells being apparently most affected in this way, although this, of course, may simply be due to the fact that the form of these cells is such that any irregularity would be more readily noticed. In the pyramidal layer of all parts of the brain are to be seen numbers of cells lying obliquely, horizontally, or completely upside down, and whose apical processes point

in all directions; these are seen in sections stained by the Silver method, as well as in Nissl and Polychrome specimens.

(3) Imperfect development of the nerve-cells.—With the object of comparing the appearance of the nerve-cells in amentia with those occurring in a healthy brain at various periods of its development, a microscopical examination was made of different portions of the cerebral cortex from embryos of seven and eight months, and from children of two and four weeks old, which were kindly placed at my disposal by Dr. Bolton. In these brains the various stages in the development of the nerve-cell can readily be traced, and are as follows: in the embryo of seven months lamination has not yet appeared, and the cells of the frontal lobe are represented by large numbers of neuroblasts; these are small round cells, possessing a close, readily-stained intracellular network, and quite devoid of processes; they are imbedded in a ground substance which, in the hardened and stained section, somewhat resembles the grain in marble (Plate I., fig. 1). In the eight months embryo the neuroblasts are somewhat larger, and the intracellular network is less close, so that the cell does not stain quite so dark, but otherwise it does not differ from that just described, and although the coloured ground substance looks somewhat like protoplasmic processes belonging to the cell, a close examination shows that the neuroblast is really devoid of processes (see Plate I., fig. 2). At this age lamination is just becoming evident. By two weeks after birth the cell has advanced very considerably in its development, and may now be readily recognised as a nerve-cell; it possesses a body, although the protoplasm composing this differs greatly from that of the mature cell, being very vacuolated, and liable to break away from the nucleus; as a rule an apical process is present in the cells of the pyramidal layer, and occasionally other processes exist, but the apical one is always the best developed, and appears to be the earliest formed (see Plate I.. fig. 3).

The above description applies to the cells in the frontal lobes of the brain only; in other regions, the motor in particular, development is somewhat more advanced, and in the eight months embryo medium-sized pyramidal cells, and also Betz cells can readily be recognised, although possessing very few processes, and being devoid of Nissl-bodies.

Referring now to the condition in primary amentia, in several of the cases examined there exist a large number of cells which have the following characteristics: the nucleus is large and globular or ovoid in shape; the intranuclear network is distinct, and in addition there are often two or more fine lines which divide the nucleus into three or four compartments; the nucleolus is eccentric, so that in some sections it cannot be seen; the cell body is represented by a few irregular strands of protoplasm, generally without any definite cell wall, and often without processes, or occasionally with a slight attempt at an apical one. Such cells represent the most imperfect form to be met with, and in the degree of their development correspond very closely with the neuroblasts which have just been described as present in the brain shortly after birth. In addition to these cells there are others whose development is slightly more advanced, and which possess a distinct cell body and recognisable processes, although the latter are not nearly so numerous as in the normal cell and their branches are exceedingly few, the apical process being invariably better developed than the others. In all of these the nucleus is large, ovoid, or pyriform, and the nucleolus is eccentric (see Plate I., figs. 4, 5, and 6, and Plate II., figs. 1, 3, and 4).

I think it cannot be doubted that the above appearances represent a condition of imperfect development; the cells retain many of the characters which are normally present at an earlier period of life, and they correspond very closely with those existing in localised areas of agenesis such as sometimes occur in the idiot's brain, as in Case No. 2. Such imperfectly developed cells were found in all the cases of primary amentia examined, in some of them being present in all parts of the cerebral cortex, although generally to greater extent in the frontal and parietal regions than elsewhere, and in far greater number in the layer of small pyramids than in any other layer. Their appearance agrees very closely with the descriptions of other writers, especially that of Bevan

Lewis, who, as early as 1879, drew attention to the presence of similar cells in the second and third cortical layers; he states, however, that these embryonic cells were only found in cases of amentia which were accompanied by congenital epilepsy, and not in cases of pure idiocy or imbecility without epilepsy. This is probably due to the fact that methods of staining at that time were not quite so advanced as in the present day, since these cells were unquestionably present in my cases of amentia without epilepsy.

The above appearances are seen in Polychrome and Nissl stained sections; in addition, I examined the cortex of several cases by means of Bolton's modification of the Silver method, and in these sections not only was great irregularity in the arrangement of the cells observed, but also the processes and their branches and genmules were decidedly fewer than normally. It seems necessary to mention this fact, although personally I am not inclined to attach much importance to it, as I doubt whether the silver method is sufficiently reliable for such comparative examinations.

There is another condition of the nerve-cell which is exceedingly common in these cases, namely, the presence of pigment. In the lowest developed cells above described such does not occur, but in a large number of those which are somewhat more advanced and which possess a wellmarked cell body, there occurs a considerable deposit of granular pigment; generally this is situated at one angle of the cell, away from the nucleus, but at times it is so abundant as to almost completely fill the cell; the pigment is yellow in colour in Nissl or Polychrome sections, but appears dark-brown or almost black in those stained with Marchi's fluid, and hence gives to these sections a most striking appearance. In several of the cases it is particularly pronounced in the cells of the Hippocampus (see Plate III., figs. 1 and 2). The exact nature and significance of this pigment is unknown, though the reaction with Marchi's fluid would suggest that it was of a fatty nature; a similar condition, but to nothing like the same extent, is frequently found in the central nervous systems of patients who have suffered from chronic nervous disease (e.g., disseminated sclerosis.

amyotrophic lateral sclerosis, progressive muscular atrophy, chronic insanity, &c.). Its occurrence in these conditions as well as in the imperfectly developed cells of amentia would appear to warrant a belief that it is an indication of defective function, the metabolism of the cell being insufficient to get rid of all the waste products, which, therefore, accumulate in the form of this black pigment. Its presence is nearly always associated with a diminution in the size and number of the Nissl-bodies.

Fibres.—The method adopted for staining the fibres has been as follows: after thoroughly impregnating the tissue with Marchi's fluid it was cut in celloidin, and the separate sections then mordanted for forty-eight hours in a solution of iron alum; they were then stained with Kulschitzky's fluid, and afterwards slowly differentiated with Pal's solution. The possibility of bleaching out some of the finer fibres by this method is not unknown to me, but if carefully performed I believe it to be still the most satisfactory method for work of this nature, and one can be more sure of obtaining sections of uniform thickness by cutting in celloidin than by freezing, an important point where comparisons have to be made. Stained as above, the sections show a very definite diminution in the number of fibres of the horizontal systems of the cortex; generally speaking, the most marked alteration occurs in those composing the outer line of Baillarger, next in the super- and inter-radial groups, and to somewhat less extent in the superficial tangential fibres (see fig. 1). The frontal and parietal regions are more affected than other portions of the brain, although it is to be remarked that for some reason or other the fibres in these two regions normally do not stain so readily as elsewhere; making due allowance for this fact, however, I think there is no doubt that the frontal and parietal regions are far poorer in fibres than they should be. In the motor region the change is comparatively slight, and in the occipital region there is practically no diminution.

Neuroglia.—The condition of the neuroglia varies very considerably in these cases; in some of them there is no increase whatever, in others a slight proliferation is present,

and in a few there is such an enormous overgrowth that it has justified the formation of a distinct variety of amentia (sclerotic) (see Plate II., fig. 2). In these latter cases the excess of neuroglia may be in the form of a diffuse irregular overgrowth, a definite band on the surface of the brain, or circumscribed nodules.

I have now examined three cases of sclerotic amentia, and in all of these quantities of neuroblasts are present, as well as many nerve-cells in a typical condition of incomplete development (See Plate II., figs. 1 and 3), so that it seems justifiable to regard the neuroglial overgrowth as to a certain extent a secondary condition, due to the imperfect development of the higher elements; not that it is exactly a substitution product, but rather that its activities of growth are less cheeked in proportion as the development of the nerve-cells is arrested. Other influences, however, than mere arrested development of the nerve-cells would seem to play a part in the production of sclerosis, since in many cases of amentia there is no neuroglial increase whatever, and it may be remarked that in cases of degeneration, such as general paralysis, similar variations exist with regard to the amount of neuroglia present. Once the process has been initiated, there seems in some instances a tendency to indefinite progression, just as occasionally happens in the secondary sclerosis following diseases of the nervous system, a fact first pointed out by Charcot.

In some of the sclerotic areas of one of these cases the remains of old hæmorrhages were found, and such might possibly be considered as the cause of the growth. This can hardly be so, however, since there was no sign of any such condition in any of the other areas, the hæmorrhage, therefore, is probably subsequent to the overgrowth.

Vessels.—The most noticeable feature about the vessels is the presence of deposits of black pigment within the endothelial cells of the capillaries; this is arranged around the nuclei of the cells, has the form of irregular granules of varying size, and appears to be identical with that in the nervecells (see Plate III., figs. 3 and 4). On casual examination this pigment might be mistaken for fatty products of de-

generation collected within the perivascular lymphatics, but more careful examination shows that the granules are really deposited within the endothelial cells; also recent degenerative changes do not exist in either the nerve-cells or fibres. The condition has an even greater resemblance to what is usually described as fatty degeneration of the capillaries, but there is no doubt that in these cases it is really pigment. It is not found in the vessels unless the nerve-cells are similarly affected, although this latter may happen without any change in the vessels. In some of the smaller arteries a similar condition is present in the cells of the adventitia.

Beyond the few small hæmorrhages present in the areas of sclerosis already described there are no vascular changes of a structural nature.

Secondary Amentia.

Two cases of this have been examined, in both of them the mental condition being the result of epilepsy occurring in early life, which is certainly the most common cause of secondary amentia.

In these two cases more or less dementia was also present, and as a description will be found in the appended abstract it is unnecessary to say much regarding them in this place. The fact may be emphasised, however, that the microscopical changes are those of degeneration (see Plate II., figs. 5 and 6), and are quite different to those occurring in primary amentia, although in one of the cases there are in addition slight indications of imperfect development of the nerve-cells. The degeneration is of a chronic nature, there being no evidence of acute change, and no recent degeneration observable in Marchi-stained The cells chiefly affected are the small and sections. medium-sized pyramids, and a considerable deposit of black pigment, like that occurring in the cells in primary amentia, is also present. The same groups of horizontal fibres also show a numerical diminution (see fig. 1).

The description here given of the condition of the nerve-cells in primary amentia is largely confirmatory of

previous observations, and some of the facts are by no means new, and the evidence now appears to be sufficiently conclusive to enable one to say that this form of mental deficiency is due to a numerical diminution, an irregular arrangement, and an imperfect development of the nervecells of the cerebral cortex. It must be remarked, however, that neuroblasts are present in the normal adult brain, also that cells which appear to be of perfect development may be seen in the brain of the idiot, even of the most pronounced type; but whereas in the former the number of neuroblasts is comparatively small and the great majority of the cells have attained complete development, in the latter the reverse is the case, the bulk of the cells being in an immature condition, and many of them also showing further indications of defective function in the presence of considerable deposits Further, the proportion of such immature cells appears to be directly related to the degree of mental deficiency, and in the milder forms of imbecility the microscopical condition is rather one of paucity of cells and of irregular arrangement than of pronounced imperfection in the individual cells.

Bevan Lewis stated that the embryonic cells which he described were particularly evident in the second and third cortical layers (the small and medium sized pyramidal cells), and my own observations are entirely in accordance with this. Incompletely developed cells occur, it is true, in all the cortical layers, but the small and middle pyramidal cells show far greater evidence of this than do the cells in other layers. Considering, moreover, the fact that it is these cells which are normally amongst the latest to attain their full development, and also that as a result of my own observations upon several cases I find they are the earliest and most affected in forms of dementia resulting from epilepsy, chronic insanity, &c., there seems strong reason for concluding that it is these cells which subserve the highest mental functions. In general paralysis other cell layers are also involved. especially the cells and fibres of the efferent path, but this disease is not an example of pure dementia. It is not improbable that the anatomical basis of idiopathic epilepsy.

and possibly also of insanity, will ultimately be proved to consist in an inherited instability, defective metabolism, or tendency to premature degeneration of these cells, the actual exciting cause of the outbreak being supplied by almost any slight disturbance of the bodily health. The convulsions are explicable by the diminished inhibition thus brought about, the various psychoses by their disordered action, and dementia by their death.

With regard to the *fibres* of the cortex less work has been done, the most important probably being that of Kaes; he drew attention to the fact that the horizontal fibres gradually increase in number up to the fortieth year, and that afterwards a diminution takes place. It is therefore of interest to note their deficiency in these cases of amentia, and also, it may be remarked, in cases of dementia; in these conditions, with the exception of general paralysis, the superficial tangential fibres appear to be less affected than the other groups, and it is probable therefore that their function is of a somewhat lower order than the fibres composing the super-radial group and the outer line of Baillarger.

Incomplete development appears to be chiefly confined to the cortex of the brain, and in all but the most pronounced cases the cells of the basal ganglia, cerebellum, and spinal cord are fairly normal. It appears to be highly probable that the cortical regions most affected are those of the frontal and parietal lobes, although further observations in this direction are greatly to be desired.

On the other hand, in the majority of cases of secondary amentia the anatomical condition is one of degeneration occurring at an age when the mental faculties are not yet fully developed, and thus incidentally producing arrest. This degeneration, if not actually restricted to, is much more pronounced in, the same cell layers and regions of the brain as are the site of the imperfect development in primary amentia. It is either of a slowly progressive nature, as in the cases due to epilepsy, encephalitis, hydrocephalus and trauma, or it may run a much more acute and rapid course, as in infantile cerebral degeneration and juvenile general paralysis.

The pathology of secondary amentia is really therefore a two-fold question, embracing, firstly, the causes which produce the local lesions of the brain, and secondly, the manner in which these act in bringing about amentia. With regard to the local lesion, the probability is that this is either due to vascular change, such as embolus, hæmorrhage, or thrombus, or to some toxic body, like that in meningitis, scarlet fever, acute anterior polio-myelitis, &c., though some of these poisons may act by bringing about vascular alterations.

Much less is known as to the way in which these local lesions give rise to amentia, but since in the majority of cases epilepsy or epileptiform convulsions result, it is possible that degenerative changes have been produced in those cell layers concerned with inhibition and the higher mental functions. The convulsions in the first instance may be Jacksonian in nature, and not attended by loss of consciousness, but subsequently they become indistinguishable from true epilepsy, finally ending in more or less dementia.

In some instances the degenerative process may be due to hereditary influences, as in idopathic epilepsy; or to an intoxication during intra-uterine life, such as that of syphilis, producing general paralysis.

It need scarcely be observed that the two best examples of secondary amentia, viz., those due to athyroidism and to sense deprivation, are not of this degenerative nature, the condition here being probably simply and purely that of arrested development.

ABSTRACT OF CASES.

Case 1.—(A. D. P., female, No. in series 199.) Primary amentia; simple variety; low grade (idiot); with occasional epileptic fits; no dementia.

Family history.—Not recorded, no friends living.

Clinical.—Idiotic from birth and subject to chorea, but not epileptic. Admitted to asylum aged 10; very little intelligence; unable to speak or wash or dress herself, and with no idea of personal cleanliness. She did not improve in any way,

and remained practically unchanged during the whole of her life. She showed scarcely any curiosity or power of attention or imitation; she never learnt to speak, but was in the habit of constantly making a peculiar noise like the braying of a donkey; she was never able to wash, or dress, or feed herself without assistance, and was always of filthy habits. She was always a source of great trouble to the nurses and all who came into contact with her, needing almost constant attention, and at times she became most excited, violent and aggressive. Very occasionally (about every three months) she had two or three epileptic fits. The patient died at the age of 36 of gangrene of the lung, the result of aspiration of a small portion of food. There were numerous stigmata of degeneracy. Circumference of skull, 20 inches.

Post-mortem appearances.—The skull was very thick and dense, there being no diploë. The dura mater was normal; the pia-arachnoid was slightly opaque along the lines of the larger fissures, but was not thickened, and stripped naturally. The brain was small, weighing (with the pons and cerebellum) 1,022 grammes; the two hemispheres were symmetrical but decidedly simply convoluted. There was no wasting and no further change obvious to the naked eye. The vessels and sinuses were healthy. The kidneys were deeply fissured owing to a partial persistence of their original lobulated condition; there was also a prolapse of the rectum.

Microscopical examination.—Sections of the brain were examined from the following regions: the middle and lower portions of the first frontal, the top of the ascending frontal (leg area), Broca's, supramarginal, and temporo-sphenoidal convolutions, the hippocampus, and the tip of the occipital lobe; also from the basal ganglia, cerebellum, medulla and spinal cord.

In all parts of the brain cortex alterations are present, but more marked in some regions than in others; on the whole, the least departure from the normal occurs in the occipital and temporo-sphenoidal lobes, and the greatest in the frontal region. As a rule the different cortical layers can be readily distinguished, but in places this is somewhat difficult under a low power owing to the incomplete differentiation of the cells composing them. In sections stained by the *Nissl* and *polychrome* methods the principal condition seen is an incomplete development of the nerve cells, especially those of the second and third cortical layers (small and medium sized pyramids). These cells are smaller and fewer than normal, and are irregularly and imperfectly shaped; as a rule the nucleus is large, the chief deficiency

being evident in the cell body, many of them indeed being little better than neuroblasts. In the deeper cortical layers there are also many cells in a condition of imperfect development, and there is also much irregularity in their arrangement; they lie in all directions—sideways, obliquely, or completely upside down; there can be no doubt on careful examination, however, that the greatest amount of imperfect development occurs in the small and medium sized pyramidal cells. Many of the cells contain a considerable collection of yellow pigment. There is a slight general increase of neuroglia, but no appreciable vascular alterations evident by this method of staining.

Corresponding with the above conditions, sections stained by the Marchi iron-alum Pal method show that the fibres composing the horizontal systems are decidedly fewer than normal. In place of the definite bundles which should occur these fibres are few and scattered, the greatest diminution is seen in those composing the line of Baillarger and the super- and inter-radial groups; the change is not so noticeable in the superficial tangential system.

Marchi sections do not show any recent degeneration in the fibres of the brain; in these sections the intracellular pigment, which was yellow by the Nissl or polychrome method, is stained black, and the large number of pigmented cells forms a very conspicuous feature of the specimens. There is also a very extensive deposit of black pigment in the endothelial cells of the capillaries.

The cerebellum is normal, Purkinje's cells being numerous, well developed, and devoid of pigment. The anterior horn cells of the spinal cord are present in normal amount, but many of them show signs of slight incomplete development, being small, irregular in shape, and with attenuated and rather fewer processes than normal. They all contain a considerable collection of yellow pigment (Nissl and polychrome). The cells of Clarke's column are perfectly normal in every way, and afford a striking contrast to those of the anterior horns. In none of the sections examined is there any evidence of acute degeneration of either cells or fibres.

Case 2.—(M. T., female, No. in series 81.) Primary amentia; simple variety; medium grade—with epilepsy; no dementia.

Family history.—Particulars incomplete.

('linical.—The patient is the seventh out of a family of eight. She has been dull, backward, and of deficient intellect

from birth; she did not walk until 5 years of age; could never learn at school; has had epileptic fits since 9 years old. She remained at home until 20 years of age, when she became too troublesome for her mother to look after and had to be sent to the asylum. On admission: she could understand what was said to her, and could converse, but in a simple and childish manner; she recognised the letters of the alphabet and could count a little, but was quite unable to do multiplication or division; she was too deficient in intelligence to do any kind of work. During the time she was in the asylum there was very little change in her condition, she had fairly frequent epileptic fits but not of a severe character, and she did not become demented. She died at the age of 24 of bronchopneumonia with tuberculosis of the small intestine. Numerous stigmata of degeneracy were present. Circumference of skull, 18½ inches.

Post-mortem appearances.—The skull was symmetrical, but very small, dense and thick, there being practically no diploë. The dura was slightly thickened; the pia-arachnoid was neither thickened nor opaque, and stripped naturally. The vessels and sinuses were healthy. The brain was very small, weighing only 660 grammes (with pons, medulla and cerebellum); the hemispheres were equal and the convolutions of average complexity, although very irregular and distorted in their arrangement. There was localised agenesis of the upper portions of the occipital lobe on both sides, the veins coming from the undeveloped convolutions being quite impervious and calcified. The grey matter of the cortex was thinner than usual, but there was no further naked eye abnormality.

Microscopical examination.—Sections of the brain were examined from the following regions: the first, second, and third frontal convolutions, temporo-sphenoidal lobe, the leg and arm areas, supramarginal and occipital lobes, the hippocampus, and optic thalamus; also from the cerebellum.

The most noticeable condition present in Nissl and polychrome stained sections is an imperfect development of the cells of the second and third layers (small and middle sized pyramids). These undeveloped cells consist of a large ovoid or pyriform nucleus surrounded by a small quantity of finely reticulated protoplasm, and without any definite cell processes; the nucleolus is frequently eccentric, and therefore in many instances is not seen at all Such cells occur in the layer of small pyramids in all parts of the brain, but they are undoubtedly more numerous in the frontal region, and least so in the central and occipital

convolutions and in the hippocampus. In the frontal region there are, in addition, many neuroblasts exactly like those present in the new-born child. Many of the large motor cells (Betz) from the top of the ascending frontal convolution are also in an imperfectly developed state, they are all shapes and sizes, the nucleus is eccentric, they possess but few processes, which are attenuated and usually devoid of chromatoplasm; the Nissl bodies of the cell are also small and irregular in shape. The cells of the hippocampus are certainly better developed than those in other regions of the cerebral cortex; the cells of the optic thalamus and cerebellum are also well developed and offer a striking contrast to those in the other regions examined. There is no increase of neuroglia, no vascular change, and no sign of acute or chronic degeneration.

In sections stained by Marchi's method it is seen that many of the cortical pyramidal cells (both small and large) contain a quantity of black granular pigment, this condition being especially marked in the cells of the hippocampus. The endothelial cells of nearly all the capillaries contain considerable deposits of black pigment. There is an entire absence of acute degenerative change in either nerve cells or fibres.

There is a numerical diminution of all the fibres of the horizontal systems, which is most evident in the frontal region and least so in the central and occipital. In the undeveloped portion of brain from the occipital region there are present large numbers of neuroblasts and also of neuroglia cells, many of these latter are undergoing division; medullated fibres (both projection and association) are present, but their arrangement is very irregular and entirely abnormal.

Case 3.—(M. F., female, No. in series 105.) Primary amentia; simple variety; medium grade; with epilepsy and slight dementia.

Family history.—Father died insane aged 59. Father's father was a heavy drinker; father's mother lived until 60 years of age but had "shaking palsy" for the last forty years; two of father's brothers and three of father's sisters died of phthisis. Apparently no injurious influences on the mother's side. The patient is the sixth out of a family of seven; one other is hemiplegic from a fit shortly after birth; another became insane after influenza but has now recovered, and two died young.

Clinical.—The patient had convulsions whilst teething, they

were slight but continued until 8 years of age, since then they have become very much worse. She was late in walking and talking, and never learned at school, and was never able to follow any regular work. Admitted to the asylum, aged 16, as she became very violent, troublesome and destructive after fits. There was evidence of considerable arrest of mental development, the patient being very simple and childish; at the age of 21 her intellectual development was no greater than that of a child of 4 or 5 years. She was subject to fairly frequent and severe epileptic fits, and was at times very violent and aggressive, in between the fits appearing to be quite happy playing with dolls or children's toys. A slight amount of dementia gradually supervened, and she died at the age of 27 of exhaustion following a succession of fits. Typical stigmata of degeneracy were present. Circumference of skull, $21\frac{1}{2}$ inches.

Post-mortem appearances.—The skull was not thickened. The dura mater was firmly adherent to the vertex of the skull, and there was slight thickening and opacity of the pia along the lines of the large fissures; the pacchonian bodies were normal. The total weight of the brain was 1,302 grammes, the right and left hemisphere being equal. The brain, although of large size, was very simply convoluted, no other naked eye change. A Meckel's diverticulum was present.

Microscopical examination.—Sections of brain were examined from the following regions: The first, second and third frontal convolutions, the leg area, the temporo-sphenoidal and supramarginal lobes, the hippocampus and the occipital lobe. Stained by Nissl's method the chief feature of these sections consists in a chronic degeneration affecting a very large number of the smaller and middle sized pyramidal cells in all parts of the brain; this is decidedly most extensive in the frontal lobe and in the hippocampus, somewhat less so in the motor region, and least marked of all in the occipital lobe. Many of these pyramidal cells have almost completely disappeared, being simply represented by an irregular collection of débris; in others the change is not quite so marked as this, and in some it is but slight; there are, however, comparatively few cells which might be described as healthy. The large Betz' cells do not appear to be altered. In addition to this atrophic process the cells are decidedly irregular and haphazard in their arrangement, but individually appear to have been fairly well developed, and there is no large number of neuroblasts or imperfectly developed cells as in some of the other cases. There is a considerable

increase in the number of young neuroglia cells in many of the sections examined, and here and there the vessels are distended, and there is slight proliferation of the endothelium of the capillaries, but on the whole there is very little vascular change to be made out in Nissl sections. In all parts of the brain there are more leucocytes than normal, and they are most numerous where the degeneration is most marked; in many instances two or three leucocytes may be seen in actual contact with one of the degenerated nerve cells, which they appear to be in process of absorbing.

In sections stained by Marchi's method the majority of the pyramidal cells are seen to be almost full of small black granules (probably pigment), and this condition is more pronounced in the large cells of the hippocampus than in any other region of the brain. There is no recent degeneration to be made out in any of the fibres. The walls of the capillaries throughout the entire brain contain abundant deposits of black pigment, and the same condition is observable in the adventitial sheaths of most of the middle sized vessels.

In Marchi iron-alum Pal sections there is seen to be a pronounced numerical diminution of all the fibres of the horizontal systems, all the different layers and all portions of the brain appear to be affected to an equal extent.

Unfortunately it was impossible to make the autopsy in this case until forty-eight hours after death, and therefore most of the nerve cells show slight evidence of early post-mortem change. At the first glance this might possibly be mistaken for an acute degeneration, but a most careful examination has convinced me that none such is really present; the irregular arrangement of the cells and the condition of chronic atrophy associated with the deposition of large quantities of pigment cannot, however, possibly be mistaken.

Case 4.—Primary amentia; Mongolian variety. (Age 15 days, No. in series 202.)

(For the central nervous system of this case I am indebted to Dr. G. A. Sunderland.)

The child, a male, presented the characteristic appearances of a Mongolian imbecile and died fifteen days after birth. Its weight when born was 4 lbs. 4 ozs.; it had an imperforate anus and a stricture of the second part of the duodenum, with dilatation of the first part forming a sac as large as the stomach;

also the left kidney was cystic and the left ureter dilated; there were also signs of congenital syphilis.

Post-mortem examination.—The brain (with pons, medulla, and cerebellum) weighed 340 grammes, being therefore slightly smaller than normal; the small size was most observable in the cerebellum, which instead of weighing one-thirteenth of the total weight was only one-sixteenth. A similar condition of the cerebellum has been previously noticed in this variety of idiocy. The brain was somewhat simply convoluted, but beyond this there was no abnormality apparent to the naked eye, and the membranes and vessels were healthy.

Microscopical examination. Brain.—Differentiation of the cells to form the various cortical layers has taken place, but many of them are far from being completely developed, especially those of the second cortical layer (small pyramids), in this situation the majority of the cells being simply neuroblasts; around some of these a few irregular strands of protoplasm are present, and in a very small number there is an attempt at an apical process, but in no case are any other processes present.

In the next layer (medium pyramids) development is slightly more advanced, and the best formed and most completely developed of all the cortical cells are seen in the layer of large pyramids, but even in this situation some of them retain their embryonic features. In all these cells the protoplasm shows a great tendency to fall away from the nucleus and to become vacuolated. A large number of the neuroblasts and also some of the nerve cells are undergoing division, and within many of them a very well marked spindle can be seen. There are no definite Meynert's columns, but there are indications of them in places. Development is less advanced in the frontal lobes than in other portions of the brain; there is no increase of neuroglia and no vascular abnormality.

Cerebellum.—There is a very plentiful and well-defined layer of granules lying superficial to the molecular layer (as is usual in the embryo and for a short time after birth). The other layers appear to be normal, and there are a fair number of Purkinje's cells present, indeed in several places there are small nests situated within the granule layer containing a large number of these cells. The dentate nucleus is of normal size and contains an abundance of cells.

Spinal cord.—The length is 150 mm.; the cervical and crural enlargements are well marked and there are no naked eye abnormalities. The cells of the anterior horns are plentiful and

well developed, the Nissl bodies being numerous and very large. The nerve fibres are not yet myelinated in the crossed and direct pyramidal tracts as well as in portions of the antero-lateral and posterior columns of the spinal cord; also in parts of the brain, mid-brain, and cerebellum.

Remarks.—Although in this case the development of the nerve cells and fibres is of course greatly behind that of the adult brain, no appreciable difference can be detected on comparing the sections with a normal brain of the same age.

Case 5.—(W. S., male, No. in series 34.) Primary amentia; sclerotic variety; medium grade; with epilepsy and subsequent slight dementia.

Family history.—Father insane. Father's mother epileptic and insane.

Clinical.—The patient has had fits since 1 year old, and has always been of deficient intellect, being unable to learn at school and subsequently doing no work. He had to be sent to the asylum at the age of 13 as he was too troublesome to be managed at home. On admission he was an imbecile of medium grade, understanding what was said to him and being able to converse, but in a very simple and childish manner; he had frequent fits and was subject to occasional paroxysms of excitement, and he was quite unemployed. He gradually passed into a state of partial dementia, and died at the age of 19 after a succession of 406 epileptic fits. Well-marked stigmata of degeneracy were present.

Post-mortem appearances.—The skull was symmetrical and the bone very dense, but not thicker than normal. The dura mater and pia-arachnoid membranes were natural, the latter stripping with undue readiness from the sclerotic portions of brain described below. There was no excess of cerebrospinal fluid.

Brain.—The weight (including pons and cerebellum) was 1,445 grammes, representing a considerable increase relative to the size of the organ; the two hemispheres were of equal weight. On stripping off the pia-arachnoid it was seen that several convolutions of both hemispheres were smoother, paler, and had a much more compact appearance than the rest of the brain, and from these the membrane stripped with great readiness, although clinging to the other regions in a natural manner. On making a section into these convolutions they were found to be extremely firm and dense owing to portions of the brain substance being

replaced by sclerotic tissue. These sclerotic areas were abundant in both hemispheres, being chiefly confined to the superficial grey matter, indeed they could not be found in the white matter of the centrum ovale; they were frequently irregular in outline, although as a rule badly defined and tending to pass gradually into the adjacent brain tissue. In the portions involved the cortical striæ were very irregular and much obscured; but on the whole the condition was one more readily appreciable by the sense of touch than that of sight, the extreme hardness of the areas being their most characteristic quality.

Attached by a broad base to the corpora striata, and projecting inwards therefrom into the cavity of the lateral ventricles, were numerous small nodules varying in size from that of a grape stone to a large pea, and consisting of a very dense tissue similar to that in the brain; on section these nodules could be seen with the naked eye to slightly infiltrate the adjacent portion of the grey matter from which they grew. The lateral ventricles were not dilated and the ependyma was normal. Cerebellum.—There was obvious naked eye atrophy of several leaflets on the upper surface of both hemispheres chiefly confined to the lobus clivi. The medulla and spinal cord showed no naked-eye change.

Microscopical examination.—Sections were examined from several regions of the brain, medulla, cerebellum, and spinal cord.

Brain: The dense areas described above are seen to consist largely of glia tissue; in some of them the glia cells are comparatively few and of a fully formed appearance, there being present an abundant meshwork of fibres; in other areas, however, the cells are much more numerous and of more recent formation, and the sclerosis is not so dense. The areas are not sharply defined but pass insensibly into the surrounding brain tissue, and they are comparatively poorly supplied with blood vessels. The nerve cells of the cortex are very irregularly arranged, their apical processes pointing in all directions; in addition a large number of them have the ordinary appearance of imperfectly developed cells, and a considerable number of actual neuroblasts are also present in the superficial layers. A large number of the cells, especially the smaller and medium sized pyramids, are also undergoing a chronic form of degeneration, being small and withered looking, the nuclear membrane often indistinct, the processes few and attenuated, and the cell body containing a considerable collection of pigment. In the region of the sclerotic areas the lamination is very irregular, probably largely the result of the neuroglial overgrowth. In some of the convolutions there is a dense band of neuroglia on the surface of the brain immediately underneath the pia-arachnoid membrane, and superficial to the tangential fibres. The nodules projecting from the corpora striata consist of almost pure glia tissue, the cells of which have a peculiar whorl-like arrangement; they are covered by an ependyma of perfectly normal structure. Sections stained by Marchi's method reveal the absence of any recent degeneration amongst the medullated fibres of the white matter. The tangential, super- and inter-radial fibres, as well as those composing the outer line of Baillarger, are considerably diminished in number in all parts of the brain. There are two or three small foci, situated within the sclerotic areas, in which granules of hæmatoidin occur, apparently indicating an old hæmorrhage; the endothelial cells of some of the capillaries contain collections of black pigment (Marchi sections), but otherwise there is no structural alteration in the vessels of either the brain or membranes, and no evidence of any inflammatory change.

Cerebellum: Sections of the atrophied portions show that there is marked diminution in the number of Purkinje's cells and also in the projection fibres; but Purkinje's cells do not contain any pigment like that in the cells of the brain.

Medulla and cord: There is slight interstitial sclerosis (no Marchi change) in the crossed pyramidal tracts traceable as far as the mid-dorsal region; also in the antero-lateral columns as far down as the fourth cervical segment. The cells of the anterior horns are plentiful and well formed, many of them contain a considerable collection of pigment which stains black with Marchi's stain, but otherwise they appear to be normal. There is no sign of any diffuse sclerosis in the cord like that met with in the brain.

Case 6.—(E. G., female, No. in series 201.) Primary amentia; sclerotic variety; low grade.

Family history.—No friends living and no particulars obtainable.

Clinical.—Admitted into the asylum aged 12 years. On admission: "Very imperfect mental development; she can only say a few words and can only understand a very little of what is said to her. She is in a condition of general helplessness,

and spends most of her time sitting in a chair, although there does not appear to be any actual paralysis. She is unable to do any kind of work or to wash or dress or even feed herself without assistance; habits are clean. She is the subject of general movements which are choreic in nature, but there are no actual convulsions." She remained in the asylum for eight years, there being no improvement. According to the notes contractures of the limbs appear to have come on, but the condition is only casually referred to and there is no account of the state of the reflexes, &c. The patient died at the age of 20 years, of broncho-pneumonia. Numerous stigmata of degeneracy. Circumference of skull at the age of 12 years was 19½ inches.

Post-mortem appearances.—The skull was small but symmetrical, and the membranes and vessels were normal. The brain was very small, weighing (with pons and cerebellum) only 896 grammes. The two hemispheres were of equal size and of fairly normal complexity. On making a section of the brain it was found to be exceedingly firm and dense, in fact, of almost cartilaginous consistence, and the whole of the white matter was very much diminished in bulk. The grey matter of the cortex was of ordinary thickness but was also very dense. The basal ganglia were firm and fibrous in appearance. The ventricles were not dilated and not granular. The cerebellum was also of considerably increased consistence, but not so markedly so as the brain. The organs of generation were incompletely developed.

Microscopical examination of the brain shows that on the whole there are decidedly fewer nerve cells present than normally, also that a large number are in a state of incomplete development; this is especially marked in the second and third layers (small and medium pyramids), where many of the cells consist of simply a large nucleus with a few irregular strands of protoplasm arranged round it, there being an entire absence of processes. Others are somewhat better developed, but exceedingly irregular in their arrangement, their apical processes pointing in all directions. There are also many cells exactly resembling the neuroblasts found in the brain of the child at birth. Throughout all the sections examined there is a great overgrowth of neuroglia both in the grey and white matter, and in some regions of the cortex there is quite a definite zone of neuroglia lying immediately underneath the pia-arachnoid membrane; this increase of neuroglia causing the lamination to appear very irregular. In the white matter of the brain, situated at a little distance below the cortex, there are found numerous scattered islets of a circular shape, within which are many incompletely developed nerve cells similar to those occurring in the layer of small pyramids, but no medullated fibres; there are also numerous neuroglia cells and fibres. These isolated portions of ganglionic matter appear to be the result of an irregularity in the process of development (heterotopia); the nerve cells within them contain granules of black pigment (Marchi) although those in other portions of the brain are devoid of pigment.

Marchi sections fail to show any degenerative changes of an acute nature in either cells or fibres of the brain or spinal cord. The fibres of the horizontal systems are much diminished in number, all the layers being affected; the fibres of the projection system are also fewer than normal. The pia-arachnoid is thickened in places; its vessels and also those of the brain are distended; the adventitial sheaths of several of the smaller arteries contain considerable deposits of black and dark brown pigment, but there are otherwise no structural changes in their walls, and no indications of hæmorrhage. The capillaries are normal.

Case 7.—(T. C., male, No. in series 1.) Primary amentia; simple variety; high grade; subsequently developing general paralysis.

Family history.—Father insane and alcoholic; father's mother and all father's brothers and sisters were also alcoholic. Phthisis on the mother's side. The patient is the second of a family of eight, no miscarriages; the first-born died aged $2\frac{1}{2}$ months, and the mother was told by the doctor that had it lived it would have been blind and an idiot. The fourth child in the family has marks of congenital syphilis and is said to be very bad tempered.

Clinical.—The patient was backward in walking and talking, and could never learn his lessons at school. At the age of 14 he began to behave very queerly, he had a "dreadful temper" and would not go to work, and he became very dirty in his habits. He was admitted to the asylum, aged 17, in a condition of mild mania; this gradually passed into dementia, and he died at the age of 19 with all the signs of adolescent general paralysis. He had several seizures in the fortnight preceding death.

Post-mortem appearances.—No marks of syphilis; state of nutrition very poor; large bedsores over both buttocks and back of sacrum. The appearances of the brain and its membranes were characteristic of general paralysis, in addition the brain was much more simply convoluted than normally. It weighed (with the pons and cerebellum) 1,167 grammes, the left hemisphere being 12 grammes lighter than the right.

Microscopical examination.—Portions of brain were examined from the following situations: First and second frontal convolutions, leg and arm areas, Broca's convolution, supramarginal and occipital lobes. In all these regions there is a paucity of cells, and many of those present are in an imperfectly developed condition, consisting of a large ovoid nucleus with very incomplete cell body and processes. Such undeveloped cells are only to be found in the second cortical layer (small pyramids), but occur in all the regions of the brain examined, although with less frequency in the central (motor) and occipital lobes. A large number of the pyramidal cells which have attained a somewhat more complete development than the above are most irregular in their arrangement, their apical processes pointing in all directions and some of them being completely upside down.

In addition to these indications of incomplete development there are also many cells undergoing a chronic degeneration; these occur in all the layers and all the regions of the brain, but to less extent in the occipital lobe than elsewhere. The affected cells are small, irregularly shaped, and withered looking, their nucleus is eccentric, and their processes are few and broken off; they show well-marked chromatolysis and contain a larger or smaller amount of pigment, which is yellow in Nissl and polychrome sections, but black in those stained by Marchi's method. There is no evidence of acute change in any of the cells and practically no increase of neuroglia, the pathological condition present being one of imperfect development to which is added a chronic degeneration.

There is a very considerable diminution in the number of horizontally coursing fibres in all parts of the brain, on the whole it is most marked in the frontal and supramarginal regions and least in the occipital; it affects most of all the fibres of the super-radial system, next the tangential fibres, and to somewhat less extent those forming the inter-radial group and the line of Baillarger. The line of Gennari in the occipital region is well developed and appears to be perfectly normal. There is some swelling of the pia-arachnoid membrane, and also slight

cellular proliferation. The vessel walls are a little thickened in places, but on the whole there is very little vascular disturbance, many of the capillaries appearing to be perfectly normal. The endothelial cells do not contain pigment in this case as in several of the others.

Spinal cord.—There is slight interstitial sclerosis with diminution in the number of nerve fibres in both direct and crossed pyramidal tracts, also in the antero-lateral and posterior columns, and in several of the incoming posterior roots. Many of the anterior horn cells are undergoing chronic degeneration similar to those of the brain, and they also contain collections of granular yellow pigment which stains black with Marchi's fluid.

Case 8.—(L. B., female, No. in series 163.) Primary amentia; simple variety; high grade; subsequently developing general paralysis.

Family history.—Particulars incomplete; mother died of general paralysis, aged 42; father is living and said to be in good health.

Clinical.—The patient has had defective eyesight and been of deficient intellect from birth. At the age of 15 she underwent a marked alteration, at times becoming noisy, violent, stamping her feet and tearing her clothing, and threatening to kill herself; at others being dazed and taking not the slightest notice of her surroundings; she gradually became quite regardless of personal cleanliness and utterly indifferent to anything which happened around her. It was in this condition that she was admitted to the asylum at the age of 15 years, and during the time she remained there she continued very depressed, silent and apathetic, with at times delusions of a persecutory nature (that she was followed by dogs, &c.). She finally passed into a state of marked dementia and died at the age of 18 with all the clinical signs of general paralysis. There were numerous stigmata of degeneracy present, as well as marks of congenital syphilis. Circumference of skull, 213 inches.

Post-mortem appearances.—The skull was symmetrical and of normal thickness and density. The dura mater was normal; the pia-arachnoid was opaque and considerably thickened in the frontal and pre-parietal regions; the pacchionian bodies were very prominent, and there was excess of clear cerebrospinal fluid. The brain was of fair size, weighing (with the pons and cere-

bellum) 1,176 grammes; in addition to a somewhat simple arrangement of the convolutions the brain presented the characteristic features of general paralysis.

Microscopical examination.—Sections of the brain were examined from the following situations: First frontal, top of the ascending frontal and Broca's convolutions, the arm area, the parietal, tempore-sphenoidal and occipital lobes. Portions of the cerebellum, pons, medulla and spinal cord were also examined.

In sections of the brain stained by the Nissl and polychrome methods there is a marked deficiency in the number of cells, also an incomplete development and irregularity in their arrangement; these abnormalities are most evident in the frontal lobes, and best marked in the small and middle-sized pyramidal cells. In addition a large number of cells throughout all parts of the brain are in a state of chronic degeneration; here and there the process is somewhat more acute, but on the whole it cannot be said that there is a large amount of acute change. There is a slight general increase in the amount of neuroglia; the vessel walls are somewhat thickened and many of them distended; a large number of the capillaries, however, appear to be perfectly normal, and their endothelial cells do not contain any pigment. The pia-arachnoid membrane is in a condition of chronic thickening, especially in the fore-part of the brain. In sections of the leg and arm areas stained by Marchi's method, there are seen to be a small number of projection fibres undergoing recent degeneration, but this does not occur in any other region. Many of the cells within all the cortical layers contain granules of black pigment.

Sections stained by the Marchi iron-alum Pal method show that there is a considerable diminution in the number of fibres of the horizontal systems, especially in the frontal, temporal and parietal regions; it is not nearly so evident in the sections examined from the motor and occipital portions of the brain, and is less extensive in the tangential fibres proper than in those situated more deeply.

In the cerebellum there is a slight diminution in the number of Purkinje's cells; also all the cells of the dentate nucleus contain a considerable quantity of black granular pigment similar to that in the cells of the brain. The olivary cells of the medulla do not contain any pigment. Many of the large motor cells of the anterior horns of the cord also contain this black pigment, but others appear to be quite healthy.

Case 9.—(F. C., male, No. in series 200.) Primary amentia; simple variety; high grade; with subsequent dementia (probably juvenile general paralysis).

(For the clinical notes and the central nervous system of this case I am indebted to Dr. F. J. Smith, Physician to the London Hospital.)

Family history.—The father has had syphilis; a brother of the patient also has "tremblings"; no further details obtainable.

Clinical.—The patient was always a quiet lad and did not seem so bright as the other children. At the age of 6 years he began to show definite ataxic symptoms (said to have been caused by a fright), chiefly marked in the legs. There was no actual loss of power complained of, but he was only able to stand with the feet apart, and was very unsteady and apt to fall whilst walking; the knee-jerks were absent on both sides, the pupils were widely dilated, considerable tremor of the eyelids was present, and there was occasional incontinence of urine. The patient gradually became worse, eventually becoming almost completely powerless and helpless in bed, and quite demented; he died at the age of 8 years.

Microscopical examination.—Sections were examined from the following regions of both hemispheres of the brain: First frontal, top of ascending frontal, Broca's convolution and the tip of the occipital lobe; also from the cerebellum, the cervical, dorsal and lumbar regions of the spinal cord, including several of the posterior spinal ganglia; also the right and left sciatics and posterior tibial nerves and the muscle of the great toe.

Brain.—Sections stained by Nissl's method show that the number of nerve-cells present is less than normal, also that there is definite imperfect development of the small and middle pyramidal cells of the cortex, more marked in the frontal region than elsewhere; the cells are also very irregular in their arrangement, their apical processes pointing in all directions, some lying laterally and others being quite upside down. In addition, a large number of the pyramidal cells are in a condition of subacute degeneration, the large motor cells from the leg areas (Betz) are much decreased in number, and of those present there are none which are normal; these degenerative changes are well marked in the frontal and central convolutions, but are not quite so pronounced in the occipital lobes. There is a considerable increase in the number of neuroglia cells, and there are also many leucocytes in the ground tissue, especially in those areas where degeneration is most marked. The vessels are distended and their walls slightly thickened, but there is practically no deposit of pigment within the endothelial cells; there is also some thickening of the pia-arachnoid membrane, and in places its vessels are much distended.

In Marchi stained sections there is seen to be well-marked recent degeneration in the fibres of the white matter, which is greatest in amount in the motor region; the perivascular lymphatics also contain a large number of cells filled with black granules and products of degeneration.

Marchi iron-alum Pal sections show a very considerable diminution in the number of horizontally coursing fibres in the frontal, ascending frontal, and Broca's convolutions, the tangential, super- and inter-radial fibres and the line of Baillarger being equally involved; within the motor regions there is also a diminution in the number of fibres of the projection system. In the cerebellum no change whatever can be made out.

Spinal cord.—Many of the anterior horn cells of the cervical, dorsal, and lumbar regions are in a condition of chronic atrophy; there are others, however, which appear to be perfectly normal. There is also extensive sclerosis with diminution in the number of fibres in both crossed and direct pyramidal tracts, but no recent degeneration. Some of the fasciculi of the peripheral nerves examined show slight chronic degeneration with increase of fibrous tissue, and the outer and middle coats of many of the medium-sized vessels are thickened. The posterior spinal ganglia show no pathological change.

Remarks.—The slight imperfect development and irregular arrangement of the small and medium-sized pyramidal cells of the cerebral cortex indicate a condition of mild imbecility. In addition there is a subacute degeneration affecting a large number of these cells, and to a less extent also, those of the anterior horns of the spinal cord; there is also a somewhat more chronic degeneration of the cells and fibres of the pyramidal tract, and the vessel walls generally are slightly thickened. I did not see this case during life, but there are many points in both the clinical and pathological appearances which suggest that this degenerative process which was superadded to the mild amentia was analogous to, if not identical with, that of juvenile general paralysis.

Case 10.—(G. A. P., male, No. in series 61.) Secondary amentia due to epilepsy; with slight dementia.

Family history.—The particulars were obtained from the patient's sister as both parents are dead, and are therefore some-

what incomplete. Father was a steady hard-working man; he had two paralytic strokes and died in the second, age 42 years. Mother was a delicate woman and always weak in her chest, she died at the age of 42 of "bronchitis" (? consumption). One male on the mother's side suffers from epileptic fits and is not quite right in his mind; he is unable to do any work. There are six brothers and sisters who are said to be healthy.

Clinical.—The patient had fits when he was quite a baby and they have continued on and off ever since. He walked and talked early and appeared to be of ordinary intelligence, but had difficulty in getting on at school, which was said to be owing to the frequent fits. On leaving school he was taught shoe-making and followed this occupation until the age of 19. He then had to be sent to the asylum on account of a mild degree of amentia with epileptic insanity. Whilst in the asylum he was found to be rational and sensible in between the fits, but at the same time very childish and simple for his age; he remained in practically the same condition until his death, which took place six months later from tuberculosis of the lungs and small intestine. He presented a somewhat low type of face, but had no pronounced stigmata of degeneracy. Circumference of skull, 21½ inches.

Post-mortem appearances of brain.—The total weight (including the pons, cerebellum and medulla) was 1,143 grammes, the left cerebral hemisphere being 487 and the right 500 grammes; the membranes were natural and the convolutions, beyond being perhaps a little simple in nature, showed no naked eye atrophy; the entire brain was very edematous.

Microscopical examination.—Many neuroblasts and incompletely developed cells are present in the second and third layers (small and medium-sized pyramids); similar cells occur, but less numerously, in the deeper cortical layers; Betz' cells are well developed and appear quite normal. Many of the cells are also very irregular in their arrangement.

These indications of arrested development are slight, and on the whole it cannot be said with certainty whether any particular regions are specially affected.

In addition to this change the majority of the smaller cells have greatly swollen nuclei, but I am inclined to think that this is rather the result of the ædematous condition of the brain than indicative of an acute degeneration; a very large number of the small and medium-sized pyramids are, however, in an undoubted condition of chronic degeneration, and not a few of

them are undergoing actual disintegration. Most of these cells also contain a considerable collection of black granular pigment (Marchi stained sections). These chronic degenerative changes occur in all portions of the brain examined, but are chiefly confined to the cells of the second and third layers, and the large motor cells (of Betz) show no pathological alteration. There are numerous young neuroglia cells present in all the sections, and also an increase in the number of leucocytes, which is most marked where the degeneration is most extensive. The vessels show some evidence of a chronic disturbance in a slight thickening of their walls, and there is a considerable deposit of black pigment in the endothelium of the capillaries and the adventitial sheaths of the smaller arteries (Marchi sections).

The fibres of the horizontal systems are diminished in number, the outer line of Baillarger and the super- and inter-radial fibres being affected to a much greater extent than the superficial tangential ones, and the diminution being decidedly more marked in the frontal and parietal lobes of the brain than elsewhere. There is no recent degeneration observable in Marchi stained sections. The pia-arachnoid membrane is slightly thickened and its vessels distended in places. There is no change in the cerebellum.

Case 11.—(R. M., male, No. in series 62.) Secondary amentia due to epilepsy, with considerable dementia.

Family history.—Particulars very incomplete. Patient's father suffered from epilepsy and there is phthisis on the mother's side.

Clinical.—The patient seemed all right until the age of 12 years, when epileptic fits made their appearance. For a few years after their onset he was able to work as an errand boy, but had then to be sent to the asylum owing to attacks of violence and excitement after the fits. Whilst in the asylum he was at times very aggressive and troublesome, and subject to violent outbursts of epileptic excitement. In addition he was somewhat simple-minded and showed evidence of slight arrest of intellectual growth; on one occasion he attempted to commit suicide by strangulation. This condition gradually passed into one of dementia, and after a few years he had become quite lost and indifferent to his surroundings and totally unable to give any account of himself. He died at the age of 25 years of acute

ulcerative phthisis. Physically he was well grown and well developed and had no marks of degeneracy. Circumference of skull, $21\frac{3}{4}$ inches.

Post-mortem appearances.—The skull is very dense but not thicker than usual. The dura mater is normal; the pia-arachnoid membrane strips very readily and is thickened and opaque over the fronto-parietal region; there is also considerable increase of cerebrospinal fluid; the vessels and sinuses are engorged with blood. The brain is of fair size, weighing (with the pons and cerebellum) 1,410 grammes, the left hemisphere being 15 grammes lighter than the right; the organ is fairly well convoluted but considerably wasted, especially in the frontal and pre-occipital regions, the ventricles are dilated and contain an excess of clear fluid; no other change is apparent to the naked eye.

Microscopical examination.—Sections of the brain were examined from the following regions: The middle and lower part of the first frontal convolutions, the leg and arm areas, the supra-marginal, occipital, temporo-sphenoidal lobes and the hippocampus. In Nissl and polychrome stained sections the principal change present is a chronic atrophy chiefly affecting the small and medium-sized pyramidal cells; this change is well marked in all parts of the frontal and Rolandic regions, least so in the temporo-sphenoidal, occipital and hippocampus; indeed in the latter situation the majority of the cells appear to be normal. In the motor region some of the large pyramidal cells of Betz show a similar change, but on the other hand there are many which are healthy and there is no doubt that the chief alteration exists in the small and medium-sized pyramids. There is no indication of neuroglial overgrowth, and but little of structural vascular change, although here and there, especially in the regions where the degeneration is most marked, the vessels are much distended, and in these same regions there are also a considerable number of leucocytes of various sizes amongst the degenerated nerve-cells; in many instances they appear to be in contact with the protoplasm of the atrophic cell.

Marchi stained sections do not reveal any recent degeneration in any of the regions examined. In all parts of the brain there are seen to be many cells containing small collections of granular pigment which stains black by this method, and the endothelial cells of the capillaries also contain a quantity of similar black granules.

In sections stained by the Marchi iron-alum Pal method there is seen to be a marked diminution in all the horizontally coursing fibres; this diminution is decidedly greatest in the frontal and supramarginal regions, next in the Rolandic and temporo-sphenoidal, and least of all in the occipital; speaking generally, it chiefly affects the super-radial fibres and those composing the line of Baillarger, the superficial tangential fibres being involved to less extent.

Case 12.—(J. H., male, No. in series 33.) Epilepsy resulting from a gross lesion of the brain probably due to asphyxia neonatorum; no amentia; no dementia.

Family history.—Good on both sides; no history of insanity, alcoholism or phthisis.

Clinical.—The patient has had paresis of the right hand, arm and foot, and has also suffered from occasional fits since birth; whilst he was under observation in the asylum the fits were typically epileptic, but no information can be obtained as to their nature previous to this. He was admitted to the asylum, aged 28, owing to the violent and impulsive outbursts which occasionally accompanied the fits; in between these attacks he was an intelligent and pleasant man, quite capable of giving a thoroughly rational account of himself and of looking after his own interests, there being no amentia nor dementia. The paresis chiefly affected the finer movements of the right hand and foot; he could walk quite well with a slight dragging of the right leg, and could make use of the hand for many purposes; he could not, however, write with it, but had learned to do so with the left hand. The muscles of the thenar and hypothenar eminences and the interossei were less developed in the right than in the left hand, and occasional athetoid movements were also observed to take place. There was no paresis of any muscle supplied by cranial nerves. The knee-jerks were exaggerated but equal on the two sides; the plantar, cremaster and abdominal reflexes were normal and there was no ankle clonus. The pupils were equal and reacted readily to light and accommodation. Cutaneous sensation appeared to be normal all over the body. He remained in the asylum for seven years, having on the average about four or five epileptic fits monthly; at the time of the fits being violent, aggressive and untrustworthy, but in between them showing no mental abnormality. He died at the age of 35 years from exhaustion following a succession of fits. There were no stigmata of degeneracy present.

Post-morten examination.—The right hand, arm and leg are slightly shorter and smaller than those of the left side.

The skull as seen from the outside is asymmetrical, the left parietal eminence being decidedly less prominent than the right, and the skull being somewhat flattened in this region; there is, however, no difference in the thickness of the bone on the two sides, neither of the vertex nor the base.

Membranes.—The dura mater is normal; the pia-arachnoid is opaque, thickened, and of greatly increased vascularity over a considerable area on the external surface of the left hemisphere which comprises the following convolutions: the whole of the ascending frontal and ascending parietal, the posterior portion of the superior frontal, and the convolutions above and in front of the interparietal sulcus as far back as the parieto-occipital fissure. It is thus somewhat wedge-shaped in appearance, with the base of the wedge at the great longitudinal fissure and the apex at the anterior part of the Sylvian fissure. Over this area the pia is closely adherent and cannot be removed without causing decortication, but it is perfectly natural in the other parts of the brain.

Brain.—The left hemisphere weighs 105 grammes less than the right; it is shorter and smaller as a whole, but there are no cyst-like depressions and no dilatation of the lateral ventricle. The main sulci are somewhat distorted in their position and arrangement, but with a little difficulty they can all be traced. The right hemisphere is perfectly normal in every way. The basal ganglia, corpus callosum, olfactory bulbs and optic commissures are also normal.

The condition of the pia-arachnoid membrane and the underlying brain in the area above described may perhaps best be designated as one of chronic meningo-encephalitis, and it is probably the result of meningeal hæmorrhage or thrombosis occurring during protracted delivery.

Microscopical examination.—Several portions of the brain were examined from the diseased area as well as from corresponding and other parts of the normal right hemisphere. Sections from the crura, pons, medulla, cerebellum and spinal cord were also examined. Those from within the diseased area have the following appearances: At frequent intervals there are foci in which the nerve-cells are considerably diminished in number and much jumbled up in arrangement, in these situations there

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being no definite Meynert's columns or even readily distinguishable layers; there is also a considerable increase of neuroglia cells and of leucocytes, and the vessels are much distended. In other portions the change is less marked and the arrangement of the cells approaches more nearly to the normal; throughout the whole of the affected motor region, however, there is a deficiency in the large-sized pyramidal cells; in the leg centre, in place of the usually very obvious collection of Betz' cells there is a very evident pale, clear zone almost devoid of cells of any kind. There are no neuroblasts or undeveloped cells to be seen within the diseased area, but many of the cells contain small collections of pigment, which is yellow in Nissl or polychrome sections, but black in Marchi stained sections; also some of the smaller pyramids appear to be undergoing a chronic form of atrophy. In sections examined from the opposite healthy hemisphere and also from the unaffected regions of the left hemisphere no pathological change can be discovered; in the leg area of the unaffected right side, however, there are present a truly enormous number of Betz' cells, certainly far more than I have ever observed before, and this fact, taken in conjunction with the clinical features of the case, would strongly suggest that a compensatory increase has taken place in these cells to make up for those rendered useless by the morbid process affecting the left hemisphere. There are no indications of chronic degeneration on this side of the brain like those on the opposite one. The horizontally coursing fibres show no diminution whatever in any of the regions examined. No recent degeneration is observable in any portion of the brain in sections stained by Marchi's method. The endothelial cells of the capillaries and also the adventitia of the smaller arteries contain black pigment, but the vessels are otherwise healthy. The pia-arachnoid membrane over the diseased area is considerably thickened and very vascular. The cerebellum is quite healthy. There is slight interstitial sclerosis with diminution in the number of nervefibres in the efferent tract coming from the left hemisphere, which can be traced through the crura, pons, medulla and cord.

I wish to take this opportunity of thanking Dr. F. W. Mott, F.R.S., Pathologist to the London County Asylums and Director of the Pathological Laboratory, for suggesting this enquiry, and for the great kindness and encouragement which I have constantly received during the course of this

investigation; also of acknowledging my indebtedness to the members of the London County Council for the Research Scholarship which I have held during the last two years, and to which, with its excellent opportunities for clinical and pathological work, this enquiry is mainly due.

I also wish to express my sincere thanks to-

Dr. R. R. ALEXANDER, Medical Superintendent, Hanwell Asylum; Dr. W. J. SEWARD, Medical Superintendent, Colney Hatch Asylum; Dr. J. M. Moody, Medical Superintendent, Cane Hill Asylum; Dr. R. Jones, Medical Superintendent, Claybury Asylum; Dr. F. R. P. TAYLOR, Medical Superintendent, Darenth Asylums; Dr. C. CALDECOTT, Medical Superintendent, Earlswood Asylum.

Both they and their assistant medical officers have given me every possible facility for the examination of patients and their relations, and have spared themselves neither time nor trouble in helping me in every way.

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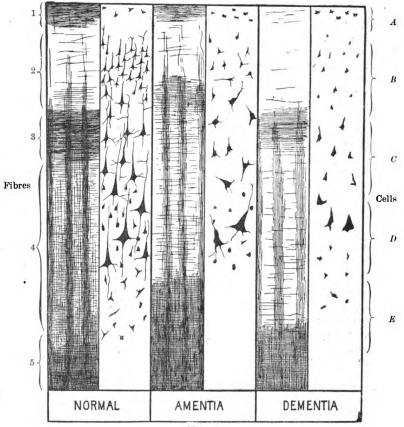


Fig. 1.

Microscopical Sections of the Frontal Cortex in Dementia, Amentia, and the Normal Conditions (semi-diagrammatic), drawn by A. F. Tredgold.

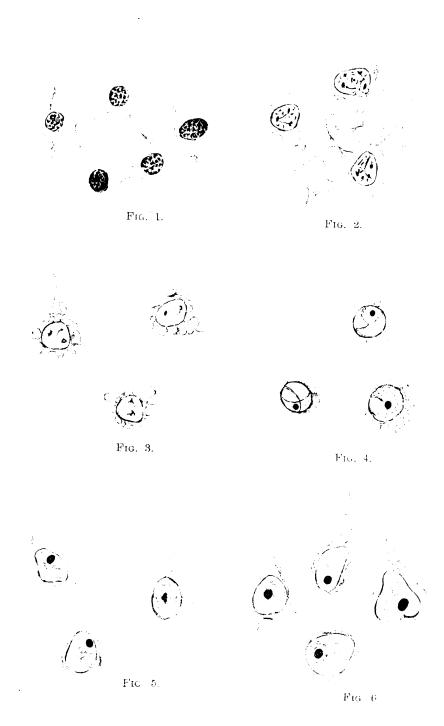
On the left of each are shown the *fibres* as they appear in sections stained by the Marchi-Pal method, on the right the *cells* as they appear in Nissl

sections. The various layers are as follows :-

FIBRES.—(1) Tangential, chiefly formed by the ramifications of the collateral processes from cells at A, B, C, and D, also the terminals of some of the fibres forming the medullary rays. This line is normally well defined; in amentia it is somewhat diminished, in dementia markedly so. (2) Superradial, a few horizontally coursing fibres are situated here; but this region is chiefly occupied by cells (B). (3) Outer line of Baillarger (line of Vicq d'Azyr), horizontally coursing fibres composed of collaterals from cells at B, C, and D, a well-marked line normally, much diminished in amentia and dementia. (4) Inter-radial, a less definite bundle, probably of similar constitution to (3), diminished in amentia and dementia. (5) White matter of centrum ovale. The vertical bundles are composed of axones from B, C, and D, and of medullated fibres from other regions of the brain.

CELLS.—(A) Neuroglia and small irregular nerve-cells. (B) Small and (C) Medium pyramids. In amentia there are comparatively few cells in these layers, and those present are irregular in arrangement and of incomplete development; in dementia many of these cells are in an advanced state of degeneration. (D) Large pyramids, similar changes to those in the preceding layers, but not so extensive. (E) Polymorphous cells. It will be noticed that in amentia the whole cortex is much thinner than in the normal condition; this is principally due to the defective development of the cells at

B, C, and D, but especially to those at B.



A. F. Tredgold, del.

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Bale & Danielsson, lith.

PLATE I.

- Figures 1, 2, and 3 are normal nerve-cells at various periods of development. Figures 4, 5, and 6 are nerve-cells in a condition of incomplete development, from cases of amentia.
 - Fig. 1.—Neuroblasts from the frontal lobe of a 7 months' feetus.
 - Fig. 2.—Neuroblasts from the frontal lobe of an $8\frac{1}{2}$ months' feetus.
- Fig. 3.—Medium-sized pyramidal cells from the first frontal convolution of a child two weeks old.
- Fig. 4.—Incompletely developed cells (small pyramids) from the first frontal convolution of Case 2. Age, 24 years.
 - Fig. 5.—Ditto from Case 1. Age, 36 years.
- Fig. 6.—Incompletely developed cells (middle-sized pyramids) from the motor area of Case 6. Age, 20 years.
- All the above are stained by the Nissl method, and drawn as seen under $_{12}^{-}$ in. oil immersion lens.

PLATE II.

- Fig. 1.—Small pyramidal cells from the frontal lobe of a case of sclerotic amentia (Case 5), showing irregular arrangement and imperfect development
 - Fig. 2.—Neuroglia cells from a case of sclerotic amentia (Case 5).
- Fig. 3.—Medium-sized pyramidal cells from a case of sclerotic amentia, showing irregular arrangement and imperfect development.
- Fig. 4.—Incompletely developed cells from the third layer (medium pyramids) of the motor cortex of Case 2, showing large ovoid nucleus, with eccentric nucleolus, and small cell body with deficient processes.
- Fig. 5.—Small pyramidal cells from the first right frontal convolution of a case of secondary amentia (Case 11), showing a condition of degeneration
- Fig. 6.—Middle-sized pyramidal cells from the frontal lobe of a case of secondary amentia (Case 10), showing a condition of degeneration.

Stained by the Nissl method, and drawn as seen under $\frac{1}{12}$ in. oil immersion lens.

PLATE II.



Fig. 1.



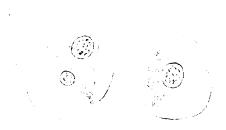
FIG. 2.



Fig. 3.



Fig. 4.



F16. 5.



F16. 6.

A. F. Tredgela, del.

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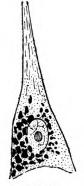
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PLATE III.





Fig. 1.





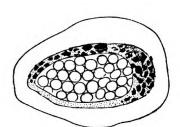
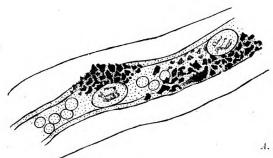


Fig. 3.



A. F. Tredgold, del.

Fig. 4.

Fig. 1.—Cells from the hippocampus of Case 3, showing the presence of an abundant deposit of black pigment.

Fig. 2.—Middle-sized pyramidal cell from the frontal region of Case 3, showing deposit of black pigment.

Fig. 3.—Transverse section of a small artery from the brain of Case 2 showing deposit of black pigment within the endothelial cells similar to that in the nerve-cells.

Fig. 4.—Longitudinal section of a capillary from the brain of Case 2, showing deposit of black pigment around the nuclei of the endothelial cells.

Stained with Marchi's fluid, and drawn as seen under $\frac{1}{12}$ in. oil immersion lens.

THE HISTOLOGICAL BASIS OF AMENTIA AND DEMENTIA.

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Assistant Pathologist and Medical Officer in charge of the Patients at

Claybury Hall.

CONTENTS.

PART I.—The Morbid Anatomy of Dementia, together with certain observations on the General Pathology of Mental Disease (p. 426).

PART II.—The Histological Basis of Amentia and Dementia. (24 tables in addition to those in text, 22 photographs arranged on 6 plates) (p. 546).

GENERAL INTRODUCTION.

THE following paper contains the results of a research on the physical basis of mental disease, the method used being that of micrometric examination of the cortex cerebri.

Certain conclusions bearing on the subject, which were obtained prior to the present research, were published in a previous communication.¹ These were, in effect, that the depth of the pyramidal layer of nerve-cells in normal aments (infants) and in dements varied inversely with the degree of amentia or of dementia present in each case. These results were at the time of publication confined to the visuo-sensory (primary visual) and the visuo-psychic (lower associational) areas of the cortex cerebri. They form the basis of the present investigation, which has been carried on in Claybury during the past three years.

Part I.—In order that suitable cases might be selected for the purposes of study, it was first necessary to deter-

¹ Phil. Trans., 1900, pp. 165-222.

mine whether any constant relationship existed between the morbid appearances found in many cases of mental disease and the clinical types of insanity manifested by the patients. This has been shown to be the case, and the first part of the paper contains the conclusions derived from a careful clinical and pathological study of 200 cases of mental disease (excluding dementia paralytica) which appeared consecutively in the Claybury mortuary. This part of the paper is completed by an account of the etiology and pathology of dementia paralytica, which is necessarily introduced in order to demonstrate the relationship which, in the opinion of the writer, exists between this and other varieties of mental disease. Whilst from the general point of view this part of the research derives much of its value from the writer's previous asylum experience, the facts made use of have been obtained by personal clinical and pathological observation in the Claybury asylum and mortuary.

The wide scope of the subject, and the necessity, in view of the second part of the research, of personally settling many points on which varying statements are made by different authors, have compelled the writer to limit himself to the recording and classifying of his own observations.

In Part II. are contained the results of micrometric examination of the cortex cerebri in twenty cases. illustrate the variations in the depth of the cortical celllayers which occur in normal aments (fœtuses and infants), normal adults, imbeciles of different grades, and cases of chronic and recurrent insanity without dementia, of severe dementia, of gross dementia, and of gross dementia paralytica.

These cases have been obtained from several sources, but have largely been selected from the material available in the Claybury mortuary. In justification of the somewhat positive conclusions contained in this part of the paper, the writer wishes to state that, prior to the commencement of the present research, he had had some four years' successful experience of the method which has been adopted, and can consequently guarantee the correctness of the results.

Part I.

SUMMARY OF CONTENTS.

INTRODUCTION AND METHOD.

MORBID ANATOMY OF MENTAL DISEASE, a clinico-pathological description of 200 cases of insanity, occurring as consecutive deaths (p. 429).

- (I.) Group I.—Insanity without dementia (p. 430).
- (II.) Group II.—Insanity with appreciable dementia (p. 439).
- (III.) Group III.—Insanity with moderate dementia (p. 453).
- (IV.) Group IV.—Severe dementia with symptoms of insanity (p. 461).
- (V.) Group V.—Gross dementia (p. 467).
- (VI.) General summary of morbid appearances (p. 471).

THE ACTION OF FORMALIN ON THE CEREBRAL HEMISPHERES (p. 477).

DEGENERATION OF THE CEREBRAL VESSELS IN MENTAL DISEASE (p. 479).

THE PATHOLOGY OF DEMENTIA (p. 487).

THE PATHOLOGY OF SUBDURAL DEPOSITS (p. 489).

THE EFFECT OF GRAVITY ON THE INTRACRANIAL CONTENTS IN THE CADAVER (p. 492).

THE INFLUENCE OF HEREDITY ON THE DEVELOPMENT OF MENTAL DISEASE (p. 499).

THE GENERAL PATHOLOGY OF MENTAL DISEASE, excluding dementia paralytica (p. 501).

DEMENTIA PARALYTICA. Introduction (p. 506).

- (I.) Etiology (p. 506).
- (II.) Clinico-pathological types of the disease (p. 519).
- (III.) Morbid anatomy (p. 537).
- (IV.) General pathology (p. 541).

PART I.

Introduction.

In the following division of this paper, an attempt has been made, by a comparison of the mental conditions with the naked-eye morbid appearances of 200 cases of insanity (excluding dementia paralytica and, except in a few special cases, gross vascular, &c., lesions) which have appeared consecutively in the Claybury mortuary, to show that a definite relationship exists between these. It is proposed to demonstrate that the morbid changes existing inside the skull-cap in insanity vary in degree with the amount of dementia present, and are otherwise independent of the duration of the mental disease. It will further be shown that the severer grades of dementia are associated with a much more extreme degree of vascular degeneration than occurs in non-demented or less severely demented lunatics

of the same age. In the final subdivision of this portion of the paper, a series of types of dementia paralytica will be introduced, and the relationship of this disease to ordinary insanity will be discussed, and the differences in their respective etiologies referred to. It may be added that this division of this paper is concerned solely with naked eye morbid anatomy, and with the corresponding clinical facts. The general histology of the cerebral cortex in normal brains, normal aments (infants, &c.), and cases of congenital amentia, of insanity without dementia, of dementia, and of dementia paralytica, will be referred to in the second part of the paper (pp. 546-620).

Метнор.

The clinical portions of the cases to be referred to have been based on the Claybury records, the information thus obtained being supplemented by personal observation of the patients, and by enquiries from the nurses and attendants. In this manner a much more consistent record has been obtained, than would have been the case had the information been acquired second-hand from the several medical officers under whose care the patients happened to be, for apart from differences of opinion, differences in the nomenclature adopted by the several observers would have largely affected its value. The details given in the cases selected for publication here have been made as brief as possible for reasons of space, and the terms made use of have also been largely chosen with a view to brevity.

The cases have been classified clinically into five groups, into which with few exceptions they readily fall. These are as follows:—

- (I.) Cases without appreciable dementia.
- (II.) Cases with appreciable dementia.
- (III.) Cases of insanity with moderate dementia.
- (IV.) Cases of severe dementia which still showed symptoms of insanity.
 - (V.) Cases of gross dementia.

Considering that this is an approximate classification in

which mistakes must necessarily occur, and in which results are obtained from averages, it is remarkable how closely it agrees with the sub-divisions based on morbid anatomy which will now be described.

Before referring to this subject, it is necessary to draw attention to the fact that all deceased patients in Claybury are as soon as possible after death placed in the cold chamber instituted some years ago by Dr. Mott. Had it not been possible to treat all the cases in this manner, it would have been nearly or entirely impossible to satisfactorily carry out this investigation, for, in the stripping of hemispheres, post-mortem changes play such a large part in modifying the ease or otherwise with which the pia-arachnoid can be removed, that no trustworthy basis of comparison could have been made; a similar remark might be applied to many other naked-eye morbid appearances. As, however, the post-mortem conditions were constant in all the cases, the following method has been adopted with success.

The naked-eye conditions of the *dura mater* need not be referred to.

Subdural deposits.—These were carefully looked for and described in each case.

The subdural fluid.—In cases where this fluid did not extend above the tentorium, it has been referred to as "natural," or in "slight," or "moderate," or "considerable" excess. Where it extended above the tentorium, the terms "large" or "great," and "enormous" excess have been adopted.

The pia-arachnoid.—In the case of this membrane the following groups, based on the ease or otherwise with which it could be removed from the hemispheres, have been made use of:—(1) Cases where the membrane stripped naturally; (2) Cases where it stripped rather more readily than natural; (3) Cases where it stripped readily; (4) Cases where it stripped very readily; and (5) Cases where it stripped like a glove from the hemisphere. The method of stripping employed will not be referred to, as the process can best be learned by experience and a study of the arterial supply of

the brain; and also as the personal equation, as regards the terms used, plays such an important part in the grouping.

As will be seen later these five groups bear a remarkably close relationship to the five clinical groups referred to above.

The sub-arachnoid fluid has been referred to in terms similar to those used in the case of the subdural, the words actually used in any case, of course, depending on a constant personal equation.

The same remark applies to the description of the degree of dilatation or granularity of the lateral ventricles.

Fourth ventricle.—The lateral pockets containing the choroid plexuses have throughout been referred to as the "lateral sacs," and as will be seen they are granular in a very high percentage of cases. On the other hand, generalised granularity of the whole ventricle, or granularity limited to the calamus or lower half of the fourth ventricle, occurs in the experience of the writer exclusively in dementia paralytica, though in ordinary dementia the upper half of the lozenge may be somewhat granular on each side of the midline, as may also be the roof.

Cerebral vessels.—The amount of atheroma has been referred to as a whole as "slight," "moderate," or "severe," other details being in many cases added.

Hemispheres.—In each case unless reasons to the contrary existed, the weights of the hemispheres in both the unstripped and the stripped conditions have been added, together with a brief reference to the site and the amount of non-development or wasting.

Finally, the cause of death and any special general pathological conditions of importance have been referred to as concisely as was possible.

THE MORBID ANATOMY OF MENTAL DISEASE.

The 200 consecutive cases of mental disease which form the basis of this part of the paper will now be grouped and described. Each sub-class will be preceded by a short, chiefly clinical, review of the cases contained in it, and afterwards the whole series of cases will be considered from the point of view of general morbid anatomy and pathology, certain kindred subjects, of special importance or interest, being at the same time referred to.

The 200 cases to be described fall readily into the following clinical groups:—

Group I.—Cases without dementia					33		
Group II.—Cases with appreciable	dementia	ι			52		
Group III.—Cases of insanity with moderate dementia							
Group IV.—Cases of dementia wh	ich still	shov	sympt	oms			
of insanity			••		37		
Group V.—Cases of gross dementia				• •	27		
				_	200		

GROUP I.

The cases in this group are as follows:—

 (1) Various (duration of days to weeks) (2) Cases of recurrent insanity without dementia (3) Cases of an "excited" or "moral" type :— 	5
(a) Hysterics	!
(4) Imbeciles and idiots, nearly all of which are epilept	tic 8
	33

Examination of these cases demonstrates that the semblance of a scientific classification can be made, and a comparison with the selected cases examined histologically by the micrometric method in Part II. will show that the essential common feature of this group [except in certain "sane" cases in class (1)], is an incomplete development of the cortex cerebri, and not the retrogressive change which occurs in dementia.

GROUP I., CLASS (1).

Various.

Of the five cases in this class, the first, admitted as "puerperal melancholia," died in three days, and showed a large abscess in the left prefrontal region, which was a sufficient explanation of the symptoms; and in the second

case the symptoms were largely or entirely due to the pressure of a thick cake of recent blood-clot on the right motor area, death occurring five weeks after admission. In the third the great difference (obviously congenital) in the weights of the hemispheres may have been an important factor in the symptomatology. Death occurred twenty days after admission from pontine thrombosis. The fourth case is one of acute insanity occurring shortly before death from rapid pulmonary tuberculosis. The fifth case died of inhalation pneumonia in acute delirium.

GROUP I., CLASS (2).

Recurrent Insanity without Dementia.

Of the four senile recurrent cases in this class, Nos. 6, 7 and 9 call for no special reference, but No. 8 is interesting, owing to the long duration of the mental disease in association with the small and poorly developed but otherwise normal brain. As will be seen in Part II. (Case 13) of this paper, in which No. 9 is reported on microscopically, cases of this variety constitute probably the very highest grade of amentia. It is also worthy of note that in Case 8, in spite of renal cirrhosis and very gross arterial degeneration, no cerebral wasting occurred. As will be shown later, arterial degeneration is a very important, if not the chief, factor in causing the development of gross out of moderate dementia, and this case, were it alone, would suffice to demonstrate what is, of course, constantly present in numerous cases of normal senility, that vascular disease is unable (apart from severe arterial occlusions and ruptures), to react on any but a breaking down cerebrum.

Case 8.

Admitted December 30, 1893. Died January 25, 1900; female, 67 years, married. No family history.

History.—Date of certificate, March 10, 1872. Incoherent and very lost. Uses bad language. Very dirty in habits.

Course.—Memory defective. Thinks she lives at "Barracks"

in Africa. Says she is 116 years old. Noisy at night, but during the day a quiet worker in the workroom. At times incoherent; thinks many of her relations are black.

Dura and S.D.—Natural, no excess. Pia.—Natural, strips naturally. S.A.—No excess. Vents. L. and IV.—Natural. Vessels.—Highly atheromatous. A small and poorly developed brain. Right h., unstripped, 485; left h., unstripped, 480. Right h., stripped, 472; left h., stripped, 467.

Cause of death.—Pneumonia. Very gross arterial degeneration. Renal cirrhosis.

GROUP I., CLASS (3).

Cases of an "Excited" or "Moral" Type.

Of the sixteen cases in this class, all excepting No. 18, an unmarried man, aged 23 years, and suffering from hypochondriasis, are unmarried women. The three sub-classes made are perhaps not free from objection, but the cases fall fairly well into them. This variety of mental disease is especially interesting owing to its close relationship to hysteria, and it probably is the English analogue of the hystero-epilepsy and kindred states, which occur so frequently in more highly neurotic nations. These cases include all grades from the passionate and unmanageable child, who is eventually sent to an asylum, or a reformatory, after being a source of endless worry to her parents, to the older girl or woman, not infrequently a prostitute, who terrifies the nurses by the violence of her outbursts, or who is a constant source of anxiety to all the officials, under whose care she happens to be, owing to the insidious cunning of her attempts at suicide or self-mutilation. In such cases, however, it is frequently noticeable how tractable these patients are in the hands of certain individuals, and that they in many instances inspire warm feelings of regard, in spite of their emotional instability, and the endless trouble they occasion. Transient attacks of acute excitement, with complete incoherence and afterwards no recollection of the attack, are not uncommon in the severer cases, and the delusions of poisoning and conspiracy which frequently develop are readily intelligible.

HISTOLOGICAL BASIS OF AMENTIA AND DEMENTIA 433

Sub-class (a).—Hysterics.

Of the three cases in the first sub-class, Case 11 shows a marked double heredity of insanity, and is a recurrent case with a small brain, and a mental condition which suggests considerable amentia. Case 12 is of importance owing to the extensive vascular changes present, although the patient showed no dementia (see pp. 479-487).

Case 10.

Admitted February 29, 1896. Died September 12, 1901. Female, aged 31, single. No family history.

History.—Thought people talked about her. Destructive to clothing. Excited at times. Has always been hysterical.

Course.—Stupid, resistive, lies about and occasionally becomes hysterical and throws herself about. Frequently asks for a cold bath and then tries to drown herself. Makes faces when notice is taken of her. Very slovenly. Occasionally has attacks of verbigeration, when she repeats the same word or phrase for hours. Usually lies coiled up like a fœtus in utero, but, very rarely, sits up sensibly and takes her food. Blinks with her eyes and, when notice is taken of her, curls up like a hedge-hog. At times salivates most profusely.

Dura and S.D.—Natural. Some excess of fluid, probably associated with extreme emaciation. Pia.—Natural and strips naturally. S.A.—No excess. Vents. L.—Natural. Vent. IV.—A few granulations in the lateral sacs. Vessels.—Natural. Right hemisphere, unstripped, 530; left hemisphere, unstripped, 535. Right hemisphere, stripped, 510.

Cause of death.—Tuberculosis of lungs and generative organs. The patient was extremely emaciated.

Case 11.

Admitted February 12, 1898. Died June 27, 1900. Female, aged 31, single.

Family history.—Insanity on both sides marked, but all mild or recurrent cases.

History.—Immoral life. First attack at age of 25. In asylums from 1892 to 1896, being free from August 13, 1896 to February 10, 1898. Patient has always been very excitable and has had chorea. Has delusions of a religious nature. At times uses bad language.

Course.—Childish and hysterical, wilful, unreasonable, passionate, sullen and abusive. Later clean and tidy and industrious, then again very troublesome and mischievous; also destructive and apt to interfere with other patients; at times incoherent.

Dura and S.D.—Natural, no excess. Pia.—Natural. S.A.—No excess. Vents. L.—Natural. Vent. IV.—A few granulations in lateral sacs. Vessels.—Natural. Brain small and simply convoluted. Right hemisphere, unstripped, 457; left hemisphere, unstripped, 450. Right hemisphere, stripped, 450; left hemisphere, stripped, 443.

Cause of death.—Acute dysentery.

Case 12.

Admitted February 10, 1899. Died February 15, 1900. Female, 39 years, single. No family history.

History.—Very depressed and strange. Talks incoherently about religion. Quarrelsome and attempted suicide. Left home three months ago.

Course.—Depressed. Says she has not wanted to live since the death of her mother and that she has a poisonous drug in her possession, but denies intending to use it. Gives a rambling and confused account of her past life, throws herself into attitudes and frequently on the floor, saying she cannot walk. Later thinks she is pregnant (abdomen enlarging owing to the growth of a malignant ovarian tumour which eventually caused her death). Dull and depressed for some time before her death.

Dura and S.D.—Natural, no excess. Pia.—Natural. On various parts of outer and lower surfaces of hemispheres, especially the left, are small superficial softenings of a mouse-eaten appearance. S.A.—Slight excess. Vents. L.—Some dilatation. Vent. IV.—Natural. Vessels.—Large and thickened. A simply convoluted brain. Right hemisphere, unstripped, 520; left hemisphere, unstripped, 530.

Cause of death.—Malignant disease of ovary. General arteriocapillary fibrosis.

Sub-class (b) .- " Excited " Cases.

Of the five cases in this sub-class, two have hemispheres weighing only 460 grammes each, and in each of these cases the mental condition suggests considerable amentia, in comparison with the remaining three.

Cases 13 and 17 are inserted as types of this class of patient, and in the latter case there existed signs of previous syphilis and also extensive vascular degeneration. There was, however, no dementia (see pp. 479-487).

Case 13.

Admitted October 12, 1897. Died April 2, 1900. Female aged 24, single. No family history.

History.—Cause stated to be sexual intemperance. Is violent and troublesome, and refuses to answer questions. Is dangerous, destructive and suicidal.

Course.—Noisy, restless, resistive, destructive and abusive. Cries, shouts and screams, and says she is being poisoned. Is alternately quiet and tidy, and reads or works, at which times she is very reticent; or sullen, disagreeable and very dangerous. She "smashed" several times, and frequently violently attacked the nurses. Was one of the most troublesome patients in the asylum.

Dura and S.D.—Natural. No excess. Pia.—Slight thickening in the anterior frontal region, otherwise strips naturally. S.A.—No excess. Vents. L.—Natural. IV.—Natural. Vessels.—Natural. Prefrontal convolutions somewhat small. A simply convoluted brain. Right hemisphere, unstripped, 565; left hemisphere, unstripped, 565. Right hemisphere, stripped, 552; left hemisphere, stripped, 550.

Cause of death.—Gastro-enteritis.

Case 17.

Admitted November 9, 1900. Died June 9, 1901. Female, aged 59, single. No family history.

History.—Has suffered from syphilis. Is noisy, troublesome and violent. Throws things about. Is a dangerous lunatic. Talks "all sorts of rubbish."

Course.—Is grumbling and discontented. Has auditory hallucinations, and sees snakes and insects. She rapidly settled down, and till her death was one of the most difficult patients to get on with that the charge nurse had met with. She was continually grumbling and complaining, and was most irritating in behaviour to every one around her. She showed no appreciable dementia.

Dura and S.D.—Natural. No excess of fluid. Pia.—Right, natural, strips naturally. Left, slight fronto-parietal thickening,

and strips rather more readily than natural. S.A.—No excess of fluid. Vents. Lat.—Natural. IV.—A few granulations in lateral sacs. Vessels.—A moderate amount of atheroma. Brain œdematous. No wasting. Right hemisphere, unstripped, 555; left hemisphere, unstripped, 555 grammes; right hemisphere, stripped, 540; left hemisphere, stripped, 538 grammes.

Signs of syphilis.—Serpiginous scar above the middle of the left leg. Leucoderma of skin of abdomen. Aortic arch hugely dilated, of cartilaginous density, and covered with pearly-white fibrous patches and small brittle calcareous plates. Marked syphilitic scarring of the throat. Gross vascular degeneration, including the renal arteries.

Cause of death.—Acute pharyngitis and laryngitis.

Sub-class (c).—" Excited" Cases with Delusions.

Of the eight cases in the final sub-class, three have hemispheres weighing less than 500 grammes each, and in another patient, who had had a previous attack of insanity, they weigh only 445 grammes each. The significance of brainweights below the average will be referred to later. A very low grade ament, No. 28, in the next class of cases in Group 1, possessed a brain with hemispheres weighing 505 and 500 grammes respectively. As will be seen, however, in Part II of this paper, in which this case is fully considered as Case 9, the cortex was very undeveloped, being in its general average measurements almost the counterpart of that of Case 7, a female still-born infant, the only difference being in the larger area of cortex in the former. Two factors, therefore, have to be considered, apart from the actual quality of the neurones, in deciding on the functional power of a brain, namely actual weight and cortical development. As will be shown in Part II, the latter is by far the most important criterion; but the former is by no means a negligible quantity, and is of extreme importance where the latter factor is constant. The writer has consequently indicated, especially during the consideration of undemented cases, the number of brain-weights which are greatly below the normal average, and he will later refer more generally to the average brain-weight of undemented lunatics.

The following two cases are inserted as types of this class of patient:—

Case 22.

Admitted August 4, 1898. Died November 12, 1900. Female, aged 31, single. No heredity of insanity.

History.—Illness began February, 1898, and her sleep and appetite were bad for months previously. Has a silly and vacant look. Her conversation is incoherent and only partly intelligible. She "chatters silly nonsense to herself."

Course.—Rambles and chatters almost incessantly, and sometimes sings. Hesitates when told to add up simple numbers. Later on tried to commit suicide by tying her apron round her neck, by compressing her trachea and by putting her head through a window-pane. Finally, she is very impulsive and excited at times, she often smashes, she has severe hallucinations, and she talks a good deal to herself.

Dura and S.D.—Natural. No excess. Pia.—Natural; strips naturally. S.A.—No excess. Vents. L. and IV., and Vessels.—Natural. A normally convoluted but very small brain. Right hemisphere, unstripped, 475; left hemisphere, unstripped, 476. Right hemisphere, stripped, 460; left hemisphere, stripped, 460.

Cause of death.--Broncho-pneumonia.

Case 24.

Admitted March 16, 1894. Died November 20, 1899. Female, aged 42, single. No family history.

History.—First attack at the age of 33, and in an asylum in 1891. Thinks she is to be burned. Hears voices and sees angels, &c.

Course.—Has a wild expression and an erratic manner, and converses with herself. Has delusions of persecution and poisoning. Is untidy and restless at night. Later, works well, but is most irrational and incoherent, and also most fantastic in dress. Strikes work at times. Works fantastic symbols on her clothes, and talks to herself.

Dura and S.D.—Natural. No excess. Pia.—Natural. Strips naturally. S.A.—No excess. Vents. L. and IV., and Vessels.—Natural. A simply convoluted brain. Right hemisphere contains a secondary scirrhus tumour; left hemisphere, unstripped, 575; stripped, 555.

Cause of death.—Scirrhus of breast and secondary growths.

GROUP I., CLASS (4).

Idiots and Imbeciles.

The fourth and final class of patients in Group I. includes eight cases of varying severe amentia. Secondary amentia due to coarse brain lesions is, on the whole, not included, though one of the cases, No. 30, shows marked localised microgyria which is not improbably of traumatic or vascular origin. Six of the eight patients were epileptics. In five (four being epileptics) the hemispheres weighed from 500 to 600 grammes each. The remaining three cases (Nos. 28, 30, and 32), are fully considered in Part II., the histological section of this paper, as cases 9, 10, and 11. As these cases sufficiently illustrate the type under consideration, no further reference to this class will be made here.

The heredity of insanity in Group I.

Of the thirty-three cases in this group, family histories were available in fourteen. Of these a hereditary history of insanity existed in seven, or 50 per cent. It is noteworthy that of the five histories available in Class (4) (idiots and imbeciles), in four a hereditary taint existed; and the fifth, No. 30, was one of microgyria, and therefore probably was a case of secondary or accidental amentia. Of the remaining nine heredity existed in three, or 33 per cent. only.

Pathological Summary of Group I.

Class (1), five cases.—" Various." Dura and S.D.—Adherent to skull-cap in one. Large subdural blood-cake which caused pressure in one. Excess of fluid in one. Pia.—Strips rather more steadily than natural in two. S.A.—Excess in none. Vents. L.—Dilated in none, granular in one. IV.—Granulations in lateral sacs in one. Vessels.—No atheroma.

Class (2), four cases.—" Recurrent seniles." Dura.—Natural in all. No subdural deposit. Excess of subdural fluid in one. Pia.—Natural in all. S.A.—Excess on one. Vents. L.—Some dilatation in one. None granular. IV.—Granulations in lateral sacs in none. Vessels.—Atheroma in one case, in association with gross general arterial degeneration and renal cirrhosis.

Class (3) (a), three cases.—" Hysterics." Dura.—Natural in all. No subdural deposit. S.D.—Excess in one. Pia.—Natural in all.

S.A.—Excess in one. Vents. L.—Some dilatation in one, none granular. IV.—Granulations in lateral sacs in two. Vessels.— Atheroma in one case of general arterio-capillary fibrosis. (b), five cases.—" Excited." Dura.—Natural in all. No subdural deposit. S.D.—Excess in one. Pia.—Strips rather more readily than natural in five. S.A.—Excess in none. Vents. L.—One slightly dilated and granular. IV.—Granulations in lateral sacs in two. Vessels.—Atheroma in one case of vascular degeneration in association with systemic syphilis. (c), eight cases.—" Excited with delusions." Dura.—Adherent to skull-cap in one. Bony plate in dura in one and a thin S.D. film around the plate. S.D.— Excess in two. Pia.—Strips rather more readily than natural in S.A.—Excess in three. Vents. L.—Slightly dilated in IV.—Granular lateral sacs in one. Vessels.—No atheroma.

Class (4), eight cases.—"Idiots and imbeciles." Dura.—Natural in all. No S.D. deposit. No S.D. excess. Pia.—Strips rather more readily than natural in two. S.A.—Excess in none. Vents. L.—Slightly dilated in one. IV.—Granular lateral sacs in three. Vessels.—No atheroma.

Total, 33 cases.—Dura.—Thickened or adherent in 9 per cent. S.D.—Deposit in 6 per cent. S.D.—Excess in 18 per cent. Pia.—Strips rather more readily than natural in 33 per cent. S.A.—Excess in 15 per cent. Vents. L.—Dilated in 12 per cent., granular in 3 per cent., dilated and granular in 3 per cent. IV.—Granular lateral sacs in 27 per cent. Vessels.—Atheroma in 9 per cent.

Note.—In the three cases in which atheroma existed, it was a part of general vascular disease due to special causes, and was not a local degenerative condition; in other words it was accidental. Though it was extreme in all the three cases, no dementia occurred.

GROUP II.

The cases in this group are as follows:—

(1) Gross lesions of the right h	Gross lesions of the right hemisphere			h epileptiform		
convulsions	••			•••		2
(2) Adults with mental confusion	n		• •	• •	• •	9
(3)—(a) Recent senile cases	• •		• •	• •	7)	
(b) Recurrent senile cases	• •		• •	• •	10}	24
(c) Chronic senile cases			• •	• •	7)	
(4) Chronic maniacal or excited	adults		• •			3
(5) Chronic delusional adults	• •	• •	• •	• •	• •	8
(6) Epileptics	·•		• •	••	• •	6
					-	59

In this group, as in the last, it will be seen from the above subdivisions that the semblance of a scientific classification can again be made. The order followed in the first group has been as far as possible adhered to.

GROUP II., CLASS (1).

Gross lesions of the right hemisphere.

Of the two cases in this class, No. 34 is fully referred to in Part II. as Case 15. These cases present a remarkable similarity. Both are examples of gross lesion of portions of the area supplied by the right middle cerebral artery, with resulting epileptiform convulsions; both had a duration of about ten years; and in both cases morbus cordis was present, and the lesion was presumably embolic in nature. The chief difference between the cases lies in the fact that No. 34 was under asylum treatment for six years, and had shown symptoms since the fits began three years earlier, whilst No. 35 was twice under treatment shortly after the onset of the lesion, and died during a third acute attack, in the interval earning her living as a laundress. This difference is not improbably associated with the fact that the encephalon of the former weighed only 1,155 grammes, whilst that of the latter weighed 1,265 grammes, the loss of brain tissue owing to the lesion being in each case about 100 grammes.

Case 35.

Admitted May 16, 1900. Died June 12, 1900. Female, aged 59 years, widow. No heredity of insanity.

History.—Previous attacks in 1891 and 1892, and was in asylums. Has had fits for about ten years. Will not speak. Is violent and spiteful, and has screaming attacks. Was a laundress for some years before admission.

Course.—Is stuporose, feeble, wet and dirty. Is very irritable and spiteful. Has left-sided convulsions. Died within four weeks of admission, without recovering from her acute attack.

Dura and S.D.—Natural. Brown readily-detachable film over base. Excess of fluid. Pia.—Marked fronto-parietal opacity and thickening on right side, and some milkiness and thickening in F.P. region on left side. Right strips very readily in F.P.

region, and is adherent over parietal lobules. Left strips fairly readily. S.A.—Excess of fluid chiefly on the right side. Vents. L.—Dilated, chiefly the right. IV., and Vessels—Natural. Gross lesion (old and progressive) of middle cerebral area of the right hemisphere; left hemisphere apparently natural. Right hemisphere, unstripped, 485; left hemisphere, unstripped, 560 Right hemisphere, stripped, 437: left hemisphere, stripped, 530.

Cause of death-Morbus cordis.

GROUP II., CLASS (2).

Adults with Mental Confusion.

This class contains nine cases of mental confusion. The term "confused" in both the present and many of the later cases is employed to signify inability to recognise time or place, to retain recent impressions, &c. It also includes illusions of identity, where the patient, owing, probably, in many cases to some chance resemblance, mistakes strangers for acquaintances or friends, but not deep-seated and permanent delusions of a like nature. This important symptom-complex is more fully referred to in the introduction to Part II. of this paper (pp. 547-9).

Prolonged lactation is given as the cause of No. 36, and six at least of the remaining eight cases are of alcoholic origin.

Four histories were available, and in only one did hereditary insanity exist, as would be expected in cases of primarily toxic mental confusion (see p. 548). In this connection it may be noted that, of the nine cases, in only three are the hemispheres both below 500 grammes in weight, and two of these three cases are single women aged 50 and 54 years respectively. Cases 38 and 41 are inserted as types of this class. Case 38 suffered from fits, and was the only case in the class which exhibited vascular degeneration.

Case 38.

Admitted May 26, 1898. Died June 15, 1900. Female, aged 46, married. No family history.

History.—Intemperate. Illness began at the age of 41. Fits for two years. Is confused, and is annoyed by visual hallucina-

tions and has delusions of poisoning. Is dirty and careless in her habits.

Course.—Is confused and depressed and her memory is impaired. She slowly improved, but later on became depressed and quarrelsome. As a whole she was a good worker, but became confused when having fits.

Dura and S.D.—Natural. Slight excess of fluid. Pia.—Some thickening, chiefly in the fronto-parietal region. Strips readily. S.A.—Slight excess. Vents. L. and IV.—Natural. Vessels.—Slightly atheromatous. Right hemisphere, unstripped, 535; left hemisphere, unstripped, 545. Right hemisphere, stripped, 515; left hemisphere, stripped, 525.

Cause of death.—Aneurism of the thoracic aorta.

Case 41.

Admitted December 10, 1897. Died April 12, 1900. Female, aged 52, married. No family history. Father died of phthisis.

History.—Began in 1897, but for some time previously had suffered from loss of sleep and appetite. Intemperate. Confused and stupid. At times violent and noisy. Talks to imaginary persons. Has illusions of identity.

Course.—Alcoholic neuritis. Extreme mental confusion. Illusions of identity. Remote memory fair. Wet and dirty, restless, and noisy at night. Then was quieter for a time, and gradually developed delusions of persecution and poisoning. She continued noisy and unemployed till her death from recurrent dysentery.

Dura and S.D.—Natural. No excess. Pia.—Some slight milkiness and thickening of the parietal region. Strips more readily than natural. S.A.—Slight excess. Vents. L.—Slightly dilated. IV. and Vessels.—Natural. Right hemisphere, unstripped, 530; left hemisphere, unstripped, 535. Right hemisphere, stripped, 512; left hemisphere, stripped, 516.

Cause of death.—Broncho-pneumonia and dysentery.

GROUP II., CLASS (3).

Sub-class (a).—Recent Senile Cases.

Of the seven senile cases in this sub-division, all of which are probably of recent date, Nos. 45 and 46, aged 69 and 80 years respectively, died during the acute stage of their attack; Nos. 47 and 48, aged 62 and 75 years respectively, became much improved; and Nos. 49, 50, and 51, aged

from 75 to 81 years, remained unimproved. Of these, Nos. 46, 47, and 50 are inserted as illustrative types. In only two of the seven cases were the basal vessels natural, but in the remainder the atheroma was only slight or moderate. It is important to note that this amount of atheroma is much in excess of that in sub-classes (b) and (c), and probably, if the cases suffering from atheroma had lived, they would have rapidly entered one or other of the later main groups of cases. Of the seven cases, in three—Nos. 46, 49, and 51—the brains are very small, and this is not due to wasting, but is of developmental origin.

Case 46.

Admitted March 1, 1900. Died May 15, 1900. Female, aged 69, widow. Sister insane.

History.—Some months before admission became dull and cross and her sleep and appetite were bad. She is restless and refuses to speak or to eat.

Course.—Acutely melancholic. Walks about aimlessly and sighs and groans. Refuses to speak or to take food. Continued in this condition till her death ten weeks after admission.

Dura and S.D.—Adherent to the skull and somewhat thickened. Excess of fluid. Pia.—Natural. Strips rather more easily than natural. S.A.—No excess. Vents. L.—Natural. IV.—A few granulations in the lateral sacs. Vessels.—Some atheroma. The brain is a small one. Right hemisphere, unstripped, 450; left hemisphere, unstripped, 450. Right hemisphere, stripped, 440; left hemisphere, stripped, 440.

Cause of death.—Pneumonia and dysentery.

Case 47.

Admitted March 29, 1900. Died July 13, 1900. Female, aged 75, married. Father insane and intemperate.

History.—Intemperate. Illness began twelve months ago. Is sleepless, restless, and garrulous. Wanders about the house and the street partially dressed and dirty. Is afraid of robbers.

Course.—Alcoholic neuritis. Is confused and has illusions of identity. Says she has been robbed. Thinks that money has been left her. Later on improved in memory and became anxious to go home.

Dura and S.D.—Natural. Slight excess of fluid. Pia.—Natural. Strips rather more readily than natural. S.A.—Slight

excess. Vents. L.—Very dilated. IV.—A few granulations in the lateral sacs. Vessels.—Natural. Probably the above slight changes are those of simple senility only. Right hemisphere, unstripped, 525; left hemisphere, unstripped, 525. Right hemisphere, stripped, 510; left hemisphere, stripped, 510.

Cause of death.—Acute dysentery.

Case 50.

Admitted December 21, 1898. Died February 10, 1900. Female, aged 80, widow. No heredity of insanity. Husband, daughter, and two sons suffered from phthisis.

History.—Had a fit six weeks before admission and the attack followed it. Is lost and incoherent. Thinks other patients want to rob and murder her.

Course.—Memory is dulled but not much deficient. Has aural hallucinations. Says she has been robbed of property. Became dull and vacant in manner but was fairly happy and contented.

Dura and S.D.—Fronto-parietal adhesions to skull and a slight yellow stain in this region. Some excess of fluid. Pia.—Natural. Strips naturally. S.A.—Slight excess. Vents. L.—Slightly dilated. IV.—Natural. Vessels.—Moderately atheromatous. The brain is ædematous. In the floor of the left lateral ventricle is a superficial softening. Probably the changes in this case are chiefly those associated with senility. Right hemisphere, unstripped, 570; left hemisphere, unstripped, 565. Right hemisphere, stripped, 555.

Cause of death.—Rupture of the aorta.

Sub-class (b).—Recurrent Senile Cases.

The ten recurrent senile cases in this class had former attacks from three to forty years before that during which they died, and in the only four in which family histories are available a hereditary history of insanity is present in all. No. 52 was improving, but died within three weeks of admission; the remainder exhibit various common types of insanity. All but three were recent cases, but few, if any, would have recovered sufficiently for discharge had they lived. Only one of the ten cases, No. 56, eight of which are above the average age of 57 years, exhibits naked-eye atheroma of the cerebral vessels, and in this case, aged

70 years, it is slight. This small amount of atheroma offers a marked contrast to the large quantity in the sub-class of recent senile cases just referred to.

In six of the ten cases—Nos. 54, 56, 57, 59, 60, and 61—the hemispheres average less than 500 grammes each, and the small size is not due to wasting. These six cases include the four with a hereditary history of insanity, which fact is of interest.

Cases 54, 56, and 59 are inserted as clinical types of this class of case.

Case 54.

Admitted May 30, 1895. Died November 29, 1899. Female, aged 68, married. Father insane.

History.—Previously in an asylum in 1891. Was hysterical and slept badly. Is distressed in her mind. Says she is not fit to live, and that her bones are distorted and that her body is covered with tumours. Put her head in the water-closet to kill herself.

Course.—Says she is altered all over. She has no body, head or tongue; is blind, deaf and dumb, and cannot move hand or foot, or have her bowels opened. Is restless, very talkative, and requires feeding. Wants a hole dug for the body she denies. Says her whole body is unnatural. Is dirty in habits, and constantly spitting. Knows the day of the month. Says that according to scripture she has no husband.

Dura and S.D.—Adhesions to the skull in the frontal region. Excess of fluid. Pia.—Slightly milky; considerably thickened. Strips more readily than natural. S.A.—Slight excess. Vents. L. and IV., and Vessels.—Natural. The brain shows slight general wasting. Right hemisphere, unstripped, 482; left hemisphere, unstripped, 482. Right hemisphere, stripped, 460; left hemisphere, stripped, 455.

Cause of death.—Broncho-pneumonia.

Case 56.

Admitted June 23, 1900. Died June 26, 1901. Female, aged 70, single. Father insane.

History.— First attack at the age of 30, and has also been in prisons. In seven asylums, and also here in 1894. Intemperate. Thinks she can do any kind of work, and has written to the Lord

Mayor to buy her a camera, so that she can take and sell photographs. Is violent and threatening.

Course.—Gives a rambling account of why she was brought here, and has evidently been drinking. Has grandiose delusions; is full of mad projects, and is garrulous and very abusive if interrupted. Is a very troublesome patient, who at times however is quiet, and does some work. Is much troubled about her bowels. Refused food for some weeks before death. Gave all sorts of accounts of her past life. "Used to drive to the workhouse in a cab, and tell the man to ask the workhouse to pay. Was an old devil in her time."

Dura and S.D.—Natural. Great excess of blood-stained fluid. Some recent blood-clots on the right vertex. Pia.—No opacity. Moderate fronto-parietal thickening. Strips rather more readily than natural. S.A.—Considerable excess of fluid. Vents. L. and IV.—Natural. Vessels.—Thickened. A little atheroma. Right hemisphere, unstripped, 485; left hemisphere, unstripped, 480. Right hemisphere, stripped, 460; left hemisphere, stripped 455.

Cause of death.—Broncho-pneumonia.

Case 59.

Admitted December 15, 1893. Died November 18, 1899. Female, aged 59, married. Brother insane.

History.—In asylums in 1890 and 1892, and certified since January 16, 1893. Fell on the back of her head in 1889. Thought she was being followed about. Hears and talks to voices. Thinks her son and daughter are dead.

Course.—Is very noisy, has delusions of persecution, and talks continually in a rambling and incoherent manner to imaginary people outside. Has recurrent attacks of excitement about every six weeks. Will not employ herself. Continued to be noisy, incoherent, abusive and unemployed till death.

Dura and S.D.—Natural. Slight excess of fluid. Pia.—Natural. S.A.—No excess. Vents. L. and IV. and Vessels.—Natural. A natural but rather small brain. Right hemisphere, unstripped, 480; left hemisphere, unstripped, 485. Right hemisphere, stripped, 465; left hemisphere, stripped, 465.

Cause of death.—Broncho-pneumonia.

Sub-class (c).—Chronic Senile Cases.

In this class are seven chronic lunatics with very little dementia. The only noteworthy features are that they are all above the average age of 57 years, and that only two, aged respectively 67 and 76 years, exhibit any naked-eye atheroma of the cerebral vessels, and in both these cases it is slight. This should be compared with the amount of atheroma in sub-classes (a) and (b) respectively, as it entirely agrees with the amount present in the latter (recurrent seniles), and differs markedly from that in the former (recent seniles). In four of the seven cases the brains are small, and in two of these they are very small. In none of the brains has any appreciable wasting occurred. No. 62 is inserted as an illustrative case.

Case 62

Admitted March 12, 1896. Died March 6, 1900. Male, aged 58, single. No family history.

History.—Says he has been three times charged at the police station for breaking glass, which he did to escape from boys who were tormenting him.

Course.—Irrational and deluded. Has a delusion that people are following him about. Auditory hallucinations. Later seemed well, but unfit for the stress of life outside an asylum. Later on was childish. Had the delusion that he had no blood in his body, and was very slow in all his actions, but quite well behaved. Finally was dull, vacant and silent during the progress of the tubercle.

Dura and S.D.—Natural. No excess of fluid. Pia.—Slight milkiness and some thickening. Strips rather more readily than natural. S.A.—No excess of fluid. Vents. L.—Slightly dilated. Vents. IV. and Vessels.—Natural. Small prefrontal gyri. Right hemisphere, unstripped, 535; left hemisphere, unstripped, 543. Right hemisphere, stripped, 512; left hemisphere, stripped, 522.

Cause of death.—Tuberculosis of lungs.

GROUP II., CLASS (4).

Chronic Maniacal Adults.

This class includes three ordinary chronic maniacal adults, the first two of whom suffered from auditory hallucinations. The cerebral vessels were natural, and the brains were of fair weight in each case. No example is cited here, as No. 70 is fully referred to as Case 14 in Part II. of this paper.

GROUP II., CLASS (5).

Chronic Delusional Adults.

This class includes eight chronic delusional adults who, as a whole, are of the usual type. Only one of them is of special interest, namely, No. 74, which is a case of high-grade imbecility, with numerous delusions, and some degree of secondary weakmindedness. This case is reported at length from the histological standpoint in the second part of the paper as Case 12.

In all these cases the cerebral vessels were natural. In three of the eight cases the hemispheres were below 500 grammes each.

Nos. 72, 76 and 79, are inserted as illustrative clinical types.

Case 72.

Admitted May 29, 1897. Died April 10, 1901. Female, aged 38, married. No family history.

History.—Excited and noisy. Incoherent and talkative. Hears voices and rambles about religious matters.

Course.—Chatters to herself and to voices. Illusions of identity. Impulsive and somewhat aggressive. Too violent to work in needle-room but does other work well. Has delusions about electricity and considerable moral obliquity. Continued at times to be quiet and at others to be noisy and troublesome.

Dura and S.D.—Frontal adhesions. Considerable excess of fluid. Pia.—Some fronto-parietal thickening. Strips more readily than natural. S.A.—Slight excess. Vents. L. and IV., and Vessels.—Natural. Some ædema of brain, and small prefrontal gyri. Right hemisphere, unstripped, 555; left hemisphere, unstripped, 555. Right hemisphere, stripped, 527; left hemisphere, stripped, 527.

Cause of death.—Tuberculosis.

Case 76.

Admitted May 22, 1896. Died June 26, 1901. Female, aged 47. No heredity of insanity.

History.—Is incoherent and strange in manner and has sexual delusions and ideas of persecution. Thinks she is wealthy.

Course.—Is garrulous, self-assertive and vindictive. Says that she was drugged and that indecent photographs were taken of her.

Works in the laundry and the needle-room. Always wears something white on her dress as it has a special meaning. Thinks things are written in the newspapers about her. Is so easily distracted from her work that she is placed at a table by herself in the needle-room. At times works usefully. Is very annoying to the other patients at whom she swears vigorously.

Dura and S.D.—Natural. Marked excess of fluid. Pia.—Slight fronto-parietal milkiness. Strips rather more readily than natural. S.A.—No excess of fluid. Vents. L.—Dilated, not granular, choroid cystic. IV.—A few small granulations in the lateral sacs. Vessels.—Natural. Right hemisphere, unstripped, 445; left hemisphere, unstripped, 450. Right hemisphere, stripped, 420; left hemisphere, stripped, 425.

Cause of death.—Suppurative pyle-phlebitis.

Case 79.

Admitted June 7, 1900. Died June 14, 1901. Female, aged 48, married. Brother insane. Father drowned himself. Asthma on mother's side.

History—Is sleepless and dejected and says that she is starving. As a whole is vacant, obstinately silent and resistive. Will not attend to her own wants.

Course.—Is very miserable and distressed. Thinks that she is dead. Has numerous delusions of persecution about herself and her children. Continued self-absorbed and usually only spoke about her delusions, and was careless about her appearance. When, however, her husband visited her, she used to speak to the nurses about the untidiness of his dress and appearance.

Dura and S.D.—Adhesions in the occipital region. Excess of fluid. Pia.—No opacity. Little or no thickening. Strips rather more readily than natural. S.A.—Slight excess of fluid. Vents. L.—Natural. IV.—A very few granulations in the lateral sacs. Vessels.—Natural. Right hemisphere, unstripped, 555; left hemisphere, unstripped, 550. Right hemisphere, stripped, 540 left hemisphere, stripped, 535.

Cause of death.—Miliary tuberculosis of the lungs.

GROUP II., CLASS (6).

Epileptics.

The final division of Group II. includes six epileptics with relatively little dementia. The first four (females) were good

workers. The remaining two were males of a much lower grade of intelligence, the last, No. 85, being certainly a high-grade imbecile, and the other, No. 84, being possibly of a similar type. Nos. 82 and 84 are inserted as examples. In all the cases the cerebral vessels were natural.

In four of the six cases there was unusual inequality in the weight of the hemispheres; and in another case they were slightly below 500 grammes each in weight, and a brother of this patient was insane. In case 85 also the hemispheres only weighed 532 and 515 grammes respectively, which is low for a male, and a brother of this patient was insane.

Case 82.

Admitted December 3, 1894. Died February 12, 1901. Female, aged 60, married. Brother insane.

History.—Epileptic. Has auditory hallucinations and delusions of grandeur regarding her mental power. Is violent.

Course.—Is very excited and troublesome. Talks incessantly, and is incoherent. Her condition varied according to the presence or the absence of fits, but as a whole she continued talkative and incoherent, and was very quarrelsome. She was very unstable, though if left alone she was quiet and did a good deal of needlework.

Dura and S.D.—Natural. Some excess of fluid. Pia.—Slight fronto-parietal milkiness and thickening. Strips more readily than natural. S.A.—Slight excess of fluid. Vents. L.—Slightly dilated. IV.—A few granulations in the lateral sacs. Vessels.—Natural. The brain is ædematous. Right hemisphere, unstripped, 495; left hemisphere, unstripped, 485. Right hemisphere, stripped, 475; left hemisphere, stripped, 475. Right membranes weigh 10 grammes more than left.

Cause of death.—Pneumonia.

Case 84.

Admitted January 16, 1899. Died April 13, 1901. Male, aged 47, single. No heredity of insanity.

History.—Previous attack eleven years ago. Epileptic for years. Is depressed and has delusions of suspicion and conspiracy. Is violent before and after fits.

Course.—Is simple, childish and emphatic. Cannot give a decent account of himself. After fits, gets excited and wants to fight with everyone. Continued unchanged till death.

Dura and S.D.—Natural. No excess of fluid. Pia.—A little fronto-parietal milkiness and some thickening. Strips fairly readily. S.A.—Moderate excess of fluid. Vents. L. and IV., and Vessels.—Natural. The brain is rather watery, and the prefrontal gyri are small. Right hemisphere, unstripped, 590; left hemisphere, unstripped, 610. Right hemisphere, stripped, 570; left hemisphere, stripped, 585.

Cause of death.—Cardiac failure.

The Heredity of Insanity in Group II.

Of the fifty-two cases in this group, family histories were available in twenty-six instances, and showed a hereditary history of insanity in fifteen, or 57.7 per cent. As has already been referred to, in Class (3) (b) (recurrent seniles), four histories were available in the ten cases, and in all these heredity existed. On the other hand, there was no hereditary insanity in either of the cases of gross lesion of the right hemisphere, and it only existed in one of the four histories of patients suffering from primarily toxic mental confusion (see p. 548).

Pathological Summary of Group II.

Class (1).—Two cases. "Right-sided lesions." Dura natural. One brown subdural film. S.D.—Excess in one case. Pia.—Stripped rather more readily than natural in two cases. S.A.—Excess in two cases. Vents. L.—Right dilated in two cases. IV.—Natural. Vessels.—No atheroma.

Class (2).—Nine cases. "Mental confusion." Dura adherent to skull-cap in two cases. No subdural deposit. S.D.—Excess in five cases. Pia.—Strips rather more readily than natural in seven cases, and readily in two cases. S.A.—Excess in six cases. Vents. L.—Dilated in six cases. IV.—Granular lateral sacs in three cases. Vessels.—Atheroma in one case.

Class (3).—(a) Seven cases. "Recent seniles." Dura thickened or adherent in five cases. No subdural deposit. S.D.—Excess in six cases. Pia.—Strips rather more readily than natural in six cases. S.A.—Excess in four cases. Vents. L.—Dilated in three cases. IV.—Granular lateral sacs in four cases. Vessels.—Atheroma in five cases.

- (b) Ten cases. "Recurrent seniles." Dura thickened or adherent in one case. One recent subdural film. S.D.—Excess in eight cases. Pia.—Strips rather more readily than natural in five cases, and fairly readily in three cases. S.A.—Excess in five cases. Vents. L.—One dilated and granular. IV.—Granular lateral sacs in two cases. Vessels.—Atheroma in one case.
- (c) Seven cases. "Chronic seniles." Dura natural. No subdural deposit. S.D.—Excess in three cases. Pia.—Strips rather more readily than natural in six cases, and fairly readily in one case. S.A.—Excess in five cases. Vents. L.—Dilated in four cases. IV.—Granular lateral sacs in one case. Vessels.—Atheroma in two cases.

Class (4).—Three cases. "Chronic excited adults." Dura natural. No subdural deposit. S.D.—Excess in one case. Pia.—Strips rather more readily than natural in two cases, and readily in one case. S.A.—Excess in two cases. Vents. L.—Natural. IV.—Granular lateral sacs in two cases. Vessels.—No atheroma.

Class (5).—Eight cases. "Chronic delusional adults." Dura thickened or adherent in three cases. One subdural film. S.D.—Excess in six cases. Pia.—Strips rather more readily than natural in eight cases. S.A.—Excess in five cases. Vents. L.—Dilated in four, and granular in one case. IV.—Granular lateral sacs in six cases. Vessels.—No atheroma.

Class (6).—Six cases. "Epileptics." Dura natural. No subdural deposit. S.D.—Excess in five cases. Pia.—Strips rather more readily than natural in two cases, and fairly readily in three cases. S.A.—Excess in five cases. Vents. L.—Dilated in one case. IV.—Granular lateral sacs in two cases. Vessels.—No atheroma.

Total.—Fifty-two cases. Dura thickened or adherent in 22 per cent. Subdural deposit in 6 per cent. S.D.—Excess in 67 per cent. Pia abnormal in 92 per cent., namely:—Strips rather more readily than natural in 73 per cent., fairly readily in 13 per cent., and readily in 6 per cent. S.A.—Excess in 66 per cent. Vents. L.—Abnormal in 43 per cent, namely:—Dilated in 39 per cent., dilated and granular in 2 per cent., and granular in 2 per cent. IV.—Granular lateral sacs in 39 per cent. Vessels.—Atheroma in 17 per cent. (9 per cent. of rest of group, and 71 per cent. of sub-class (3a)).

Note.—Of the nine cases of atheroma, five occurred in the class of seven recent seniles (71 per cent), all of whom,

judging from their mental condition, would probably, if they had lived, have passed on into later main groups of cases.

Of the remaining four cases (9 per cent. of rest of group), one, No. 38, was slight, and occurred in an alcoholic epileptic, aged 46 years, who died of aneurism of the thoracic aorta; another, No. 56, was also slight, and occurred in a recurrent female, aged 70 years; and the remaining two, Nos. 66 and 64, also both slight, occurred in chronic senile male and female patients, aged respectively 76 and 67 years.

Hence in this group, as in Group I., there is an almost entire absence of naked-eye changes in the cerebral vessels.

GROUP III.

Chronic Insanity with Moderate Dementia.

The cases in this group are as follows:-

(1)		beginning	(or	first	attack), betw	een 16		_
	23 3	years		• •	• •		• •	• •	.3
(2)	Cases	beginning	(or	first	attack	c), betw	een 27	and	
	39 3	years			• •		٠		11
(3)	Cases	beginning	(or	first	attack), betw	een 4 2	and	
	57	years				••			13
(4)		beginning						and	
	70	years		••	• •	••		• •	10
(5)	Cases	beginning (or fir	st atta	ck), aft	er the a	ge of 70	years	7
(6)	Epiler	otics		••	••		•••	•••	7
								-	
									51

It has been found quite impossible to class the cases in this group into clinical sub-divisions similar to those of Groups I and II., except as regards the epileptics. The sub-divisions adopted, which are based on the age of incidence of the mental disease, appear to be on the whole less open to objection than would have been the case had an etiological or clinical basis been adopted.

GROUP III., CLASS (1).

Age of Incidence between 16 and 23 years.

This class includes three unmarried female chronic lunatics with dementia, in whom the onset of the disease

occurred respectively at the approximate ages of 16, 20, and 23 years. No. 86 is inserted as an example. None of these cases show any naked-eye atheroma.

In view of the excess of intracranial fluid, it is probable that the hemispheres in each case weighed originally 500 grammes and upwards.

Case 86.

Admitted May 29, 1895. Died April 1, 1900. Female, aged 23, single. No heredity of insanity.

History.—Symptoms for fourteen months. Hysterical, depressed and suicidal. Sees visions and says that she is hypnotised. Screams quite suddenly for hours and when asked to be quiet says that she can't.

Course.—Hysterical and self-conscious. Hides her face (she suffers from acne) as she says that it is hideous and hateful. Has auditory hallucinations. Later spent much time admiring herself in a glass and was clean and tidy. Then became silly, affected, noisy, and erotic, and later was excitable and destructive. Towards the end of her life she became lost, stupid and unemployed.

Dura and S.D.—Natural; slight excess of fluid. Pia.—Thickened, especially in the frontal region; strips readily. S.A.—Excess of fluid. Vents. L. and IV., and Vessels.—Natural. The brain shows some wasting in the prefrontal region. Right hemisphere, unstripped, 490; left hemisphere, unstripped, 493. Right hemisphere, stripped, 470; left hemisphere, stripped, 475.

Cause of death.—Tuberculosis of the lungs.

GROUP III., CLASS (2).

Age of Incidence between 27 and 39 years.

In this class are contained eleven chronic lunatics, of whom eight are females, and three are males. Of the former Nos. 89 and 93 are probably fairly pure alcoholic cases, and No. 98 has a history of intemperance; Nos. 92 and 95 are depressed, and Nos. 94 and 96 are excited cases, and No. 99 is the case of an unmarried senile female patient, who suffered from a recurrence after an interval of about twenty-five years. Of the latter, No. 90 is a similar case to No. 99, No. 91 had been in and out of asylums for upwards of forty years, and

No. 97 is a chronic delusional maniac with a marked hereditary history.

Of the four cases in which histories exist, hereditary insanity occurs in all. Only one of the eleven cases, No. 99, aged 72 years, shows any naked-eye atheroma, and in this case it is slight.

In nine of the eleven cases the hemispheres weigh above 500 grammes each. In one of the remaining two there is a heredity of insanity, and the other is a single woman, aged 72 years.

GROUP III., CLASS (3).

Age of Incidence between 42 and 57 years.

This class includes thirteen chronic lunatics, of whom eight are females, and five are males. The majority are delusional cases, and Nos. 110 to 112 are cases with mental confusion probably associated with alcoholic excess. of the latter three cases, however, Nos. 110 and 112, nakedeye atheroma of the cerebral vessels exists, and vascular degeneration may consequently bear some relation to this symptom-complex in these cases. Case 110 is inserted below, and Case 112 is referred to as Case 16 in Part II. Only two other cases of atheroma exist, namely No. 106, which is moderately affected, and has renal cirrhosis, and No. 107, in whom the affection is slight, and whose age is 76 years. In nine of the thirteen cases the hemispheres weigh above 500 grammes each. Of the remaining four, in No. 103 there is heredity of insanity and marked inequality of the hemispheres; in No. 101 there is no family history, and the patient was an unmarried woman, aged 53 years; and in the remaining two cases, if wasting be allowed for, the weights of the hemispheres would nearly or quite reach 500 grammes each.

Case 110.

Admitted March 27, 1895. Died August 20, 1901. Female, aged 48, married. No family history.

History.—Thinks that she is about to die immediately on account of the crimes and murders that she has committed. Is

sure that the woman in the next bed is her husband with his whiskers shaved off.

Course.—Depressed. Thinks she is very wicked and has acted wrongly towards God and her husband. Hears voices and sees spirits. Memory good. Is restless and confused. Has illusions of identity. Later on was restless, delusional and erotic, but most of the time worked well. Finally she was depressed and delusional and had impairment of memory.

Dura and S.D.—Very thin. Slight excess of fluid. Pia.—Slight milkiness; thickened; strips readily. S.A.—Slight excess of fluid. Vents. L.—Slightly dilated. Contain a few granulations. III.—Contains a small number of granulations. IV.—Natural. Vessels.—Considerably thickened and dilated. The brain shows moderate prefrontal wasting. Right hemisphere, unstripped, 580; left hemisphere, unstripped, 590. Right hemisphere, stripped, 550; left hemisphere, stripped, 565.

Cause of death.—Renal cirrhosis.

GROUP III., CLASS (4).

Age of Incidence between 59 and 70 years.

In this class are ten senile cases in whom the mental disease commenced at ages varying from 59 to 70 years. They are of the usual senile type, and call for no eslpecia notice. No. 117 is inserted as an example. Seven of the ten cases show naked-eye atheroma, and all the seven are between 70 and 80 years of age. In three cases, the atheroma is slight, in three it is moderate, and in one it is severe.

Of the ten cases, in three the hemispheres average below 450 grammes each. In two of these, three previous attacks of insanity had occurred, and in the third the patient had shown symptoms for seven years before admission.

Case 117.

Admitted May 28, 1896. Died May 21, 1900. Female, aged 63, widow. Father insane.

History.—Intemperate. Has shown symptoms for weeks. Vacant. Great dread of prison. Has tried to commit suicide by cutting her throat. Thinks the police are after her, and that she must pay £5,000. Confused and miserable.

Course.—Incoherent and confused. Aural hallucinations. Fears imaginary evils. Afraid she will have to pay for being here, and so stints herself of food. Finally was at times quarrelsome and interfering, but usually dull and apathetic. Memory deficient.

Dura and S.D.—Natural. Excess of fluid. Pia.—Some fronto-parietal opacity and thickening. Rest of pia strips naturally. S.A.—Some excess of fluid. Vents. L.—Somewhat dilated. Vents. IV.—A few granulations in the lateral sacs. Vessels.—Natural. The brain shows moderate fronto-parietal wasting. Right hemisphere, unstripped, 537; left hemisphere, unstripped, 537. Right hemisphere, stripped, 525; left hemisphere, stripped, 525.

Cause of death.—Morbus cordis.

GROUP III., CLASS (5).

Cases beginning after the age of 70 years.

This class includes seven cases, in whom the mental disease appeared after the age of 70 years. Four of the seven cases show naked-eye atheroma. Of these four cases, all are between 77 and 81 years of age, and all are recent cases which with a longer duration would probably have passed into Groups IV. or V. (cf. the class of recent seniles in Group II., p. 442). Of the three cases without atheroma, two, Nos. 123 and 126, are aged respectively 74 and 79 years, and the duration of their mental disease is three and five years. Case 123 is inserted as a type of this class.

In all the cases the hemispheres weighed upwards of 450 grammes, and in five of the seven they probably weighed nearly 500 grammes before the wasting had occurred. Of the two which probably did not originally weigh 500 grammes, in one there was a marked heredity of insanity and in the other there was no family history.

Case 123.

Admitted May 22, 1897. Died November 10, 1899. Female, aged 74, married. Mother and sister insane.

History.—Infantile fits. Has had symptoms for six months. Violent, dirty, and suicidal. Delusions of persecution. Chatters incoherently, and is confused.

Course.—Confused, restless, incoherent, depressed, and wet n habits. Later became childish, with impaired memory, and unable to look after herself. Then became restless and spiteful at times, biting and scratching, and spitting in people's faces.

Dura and S.D.—Natural, excess of fluid. Pia.—Very slight fronto-parietal opacity and slight thickening. Strips readily. S.A.—Some excess of fluid. Vents. L. and IV., and Vessels.—Natural. Brain somewhat watery. Considerable wasting, especially in the prefrontal region. Old softening of the right collateral fissure. Right hemisphere, unstripped, 455; left hemisphere, unstripped, 453. Right hemisphere, stripped, 435; left hemisphere, stripped, 430.

Cause of death.—Acute recurrent dysentery.

GROUP III., CLASS (6).

Epileptics.

In the last division of Group III. are seven epileptics suffering from moderate dementia, who readily fall into two groups. In the first of these are Nos. 130 and 131, in whom the epilepsy began in early life, and this is probably also true in the case of Nos. 132 and 133. All these four cases are unmarried. In the second group are Cases 134 to 136, in whom the fits apparently began later in life, and all the three had been married. Case 130 is inserted as an example of the former group and Case 135 of the latter. In none of the seven cases was there any naked-eye atheroma of the cerebral vessels, though the oldest case, No. 135, was 66 years of age.

Of the seven cases, in the three males the hemispheres weighed from 600 to 655 grammes each, and in the four females from 500 to 540 grammes each. In other words, in spite of the moderate wasting present, the lightest brains were very little below the normal weight. This agrees with the brain weights occurring in the epileptics belonging to Group II., Nos. 80 to 85, and Group I., Nos. 26 to 33, excluding No. 30 as a case of probable secondary amentia.

Case 130.

Admitted January 10, 1899. Died August 30, 1900. Female, aged 28, single. Mother insane.

History.—Epileptic since scarlet fever at the age of seven years. First attack at the age of nine years. Patient became threatening, and said that she had no memory.

Course.—Confused, but gives a good account of herself. Is dull and depressed. Resents being here, but works usefully. Had two fits a week under bromides, and one or two a day without this treatment. Some of the fits were one-sided.

Dura and S.D.—Natural. Slight excess of fluid. Pia.—Right side slightly thickened and strips more readily than natural. Left side more thickened and strips readily. S.A.—No excess on the right side. Some excess on the left side. Vents. L.—Right slightly dilated; left side more dilated. IV.—Granulations in the lateral sacs. Vessels.—Natural. Right hemisphere, unstripped, 525; left hemisphere, unstripped, 540. Right hemisphere, stripped 500; left hemisphere, stripped 507.

Cause of death.—Pneumonia.

Case 135.

Admitted November 30, 1893. Died July 29, 1900. Female, aged 66 years, widow. No family history.

History.—Epileptic. Suicidal. Is noisy, violent, and incoherent.

Course.—Ideation is slow and her memory is bad. Is excited before fits. Later on heard voices. Finally became more demented, thought she was a great thief and was very quarrelsome. Had as a rule about one fit each day.

Dura and S.D.—Natural. Slight excess of fluid. Pia.—There is some fronto-parietal opacity. The membrane is considerably thickened, and strips fairly readily except over the postero-inferior region of the brain. S.A.—Considerable excess of fluid. Vents. L.—Somewhat dilated. IV.—A few granulations in the lateral sacs. Vessels.—Natural. Both hemispheres are simply convoluted. Right hemisphere, unstripped, 510; left hemisphere, unstripped, 500. Right hemisphere, stripped, 485; left hemisphere, stripped, 475.

Cause of death.—Gangrene of the lung.

The Heredity of Insanity in Group III.

Of the fifty-one cases contained in this group, family histories were available in twenty-two instances, and these showed a hereditary history of insanity in 13, or 59 per cent.

Pathological Summary of Group III.

Class (1).—Three cases. "Onset 17-24 years." Dura natural. No subdural deposit. S.D.—Excess in three cases. Pia.—Strips readily in three cases. S.A.—Excess in three cases. Vents. L.—Dilated in two cases. IV.—Granular lateral sacs in one case. Vessels.—No atheroma.

Class (2).—Eleven cases. "Onset 27-39 years." Dura thickened or adherent in three cases. No subdural deposit. S.D.—Excess in nine cases. Pia.—Strips readily in nine cases, and very readily in two cases. S.A.—Excess in ten cases. Vents. L.—Dilated in seven cases, and granular in one case. IV.—Granular lateral sacs in eight cases. Vessels.—Atheroma in one case.

Class (3).—Thirteen cases. "Onset 42-57 years." Dura thickened or adherent in four cases. Three subdural films. S.D.—Excess in eleven cases. Pia.—Strips readily in nine cases, and very readily in four cases. S.A.—Excess in ten cases. Vent. L.—Dilated in eight cases and granular in two cases. IV.—Granular lateral sacs in four cases. Vessels.—Atheroma in four cases.

Class (4).—Ten cases. "Onset 59-70 years." Dura thickened or adherent in five cases. One subdural film. S.D.—Excess in nine cases. Pia.—Strips fairly readily in two cases, readily in eight cases. S.A.—Excess in nine cases. Vents. L.—Dilated in eight cases and granular in one case. IV.—Granular lateral sacs in four cases. Vessels.—Atheroma in seven cases.

Class (5).—Seven cases. "Onset after 70 years." Dura thickened or adherent in three cases. No subdural deposit. S.D.—Excess in seven cases. Pia.—Strips fairly readily in two cases, and readily in five cases. S.A.—Excess in seven cases. Vents. L.—Dilated in six cases, granular in two cases. IV.—Granular lateral sacs in five cases. Vessels.—Atheroma in four cases.

Class (6). Seven cases.—"Epileptics." Dura thickened or adherent in one case. No subdural deposit. S.D.—Excess in four cases. Pia.—Strips readily in four cases, and very readily in three cases. S.A.—Excess in six cases. Vents. L.—Dilated in four cases. IV.—Granular lateral sacs in three cases. Vessels.—No atheroma.

Total.—Fifty-one cases. Dura thickened or adherent in 31 per cent. Subdural deposit in 8 per cent. S.D.—Excess in 84 per cent. Pia abnormal in 100 per cent., namely:—Strips

fairly readily in 8 per cent., readily in 74 per cent., and very readily in 18 per cent. S.A.—Excess in 88 per cent. Vents. L.—Dilated in 69 per cent. and granular in 12 per cent. IV.—Granular lateral sacs in 49 per cent. Vessels.—Atheroma in 31 per cent.

Note.—Atheroma occurred in sixteen (31.3 per cent.) of the cases; in eight (15.7 per cent.) it was slight, in six (11.7 per cent.) it was moderate, and in two (3.9 per cent.) it was severe. Beyond drawing attention to this, more need not be said here as the subject will be fully referred to later (pp. 479 et seq.).

GROUP IV.

Cases of Severe Dementia which still show Symptoms of Insanity.

The cases in this group are as follows:-

(1) (?) Recent senile cases	 	 6
(2) Chronic senile cases	 	 19
[-]		12
		37

The important feature of this group is that all the cases are seniles, and that no less than thirty-three are above the average age (taken from the 200 cases), of 57 years. For convenience of reference they have been placed under the above three classes. It is an interesting fact that no less than a third of the cases have suffered from convulsions which in at least many of the cases were of vascular origin.

GROUP IV., CLASS (1).

(?) Recent Seniles.

In all these cases the important clinical feature is mental confusion. Of the six cases in the class, four have atheromatous cerebral arteries, though their ages vary between 63 and 67 years only. These cases might readily have passed into Group V. had they lived. No. 138 is inserted as an example. Little or no stress can be laid on the weight of the hemispheres where so much wasting has occurred, but it is a significant fact in view of the marked vascular changes

that the hemispheres of the males even in their present condition weigh from 505 to 610 grammes each, and the hemispheres of the females from 465 to 525 grammes each.

Case 138.

Admitted January 6, 1900. Died February 5, 1900. Male, aged 63, widower. No family history.

History—Symptoms for three months. Gives irrational replies to questions. Is confused. Is very dirty in his habits.

Course.—Is dazed and lost, and at times becomes incoherent, uneasy and restless. Wanders about the ward. Is clean in his habits.

Dura and S.D.—Natural. Excess of fluid. Pia.—Is opaque and considerably thickened, and strips very readily. S.A.—Excess of fluid. Vents. L.—Slightly dilated. IV.—A few granulations in the lateral sacs. Vessels.—Atheromatous. The brain shows fairly marked general wasting, which is especially evident in the prefrontal region. Right hemisphere, unstripped, 630; left hemisphere, unstripped, 610. Right hemisphere, stripped, 598; left hemisphere, stripped, 575.

Cause of death.—Pneumonia.

GROUP IV., CLASS (2).

Chronic Seniles.

The important clinical features in this class are again mental confusion and restlessness which pass on to dementia of a fairly severe grade. No. 154 is referred to at length in Part II. as Case 17, and Nos. 155 and 160 are inserted here as types. Of the nineteen cases in this class, in ten the cerebral arteries are natural and in nine they are atheromatous. There is thus in this class of cases less atheroma than in the class of recent seniles. This is in agreement with the fact that the patients in the class under consideration are chronic lunatics and as a whole have smaller brain weights than the cases in the recent senile class (the hemispheres of males varying from 445 to 565 grammes and of females from 370 to 545), which suggests a relatively greater degree of degeneracy in the chronic than in the recent class of case, for though in the former there is probably more wasting than in the latter it is not so appreciable as to cause such a marked difference in brain weights as exists in the two classes of cases.

Case 155.

Admitted March 7, 1894. Died August 22, 1900. Female, aged 76, single. Mother insane.

History.—Intemperate for the last three and a half years. Symptoms for six months. Is very restless and excited. Has hallucinations of smell and delusions of poisoning and persecution.

Course.—Is garrulous and has fair memory and power of attention. Has hallucinations of sight and delusions of poisoning. Later on, became quiet and a good worker. Finally became dull, and lost to time and place, though she still retained her delusions and was occasionally noisy.

Dura and S.D.—Thickened. Excess of fluid. Pia.—Considerable thickening. Strips very readily. S.A.—Large excess of fluid. Vents. L.—Dilated. IV.—Natural. Vessels.—Calcareous and tortuous. The brain is very wasted, especially in the fronto-parietal region. Right hemisphere, unstripped, 445; left hemisphere, unstripped, 445. Right hemisphere, stripped, 415; left hemisphere, stripped, 410.

Cause of death.—Cardiac failure.

Case 160.

Admitted May 26, 1896. Died September 11, 1901. Male, aged 75 years, widower. No family history.

History.—Intemperate. Is simple, childish, and confused, and has no idea of time. Is restless, sleepless, and very depressed.

Course.—Well-marked secondary dementia. Is restless and wanders about. Is depressed, and his memory is impaired. He lost the depression as the dementia increased. Was quiet and well-behaved, and quite lost to time. Thought that he had strayed into the grounds accidentally and been detained. Till his death he was able to dress himself and to attend to his own wants.

Dura and S.D.—Natural. Large excess of blood-stained fluid. Recent blood-flakes scattered over the vault (chiefly on the right side), and also over the whole base above the tentorium. Pia.—Markedly opaque and thickened. Strips very readily. S.A.—Considerable excess of fluid. Vents. L.—Moderately dilated. IV.—Granulations in the lateral sacs. Vessels.—Apparently natural. The brain shows considerable general wasting. Right

hemisphere, unstripped, 435; left hemisphere, unstripped, 445. Right hemisphere, stripped, 400; left hemisphere, stripped, 410. Cause of death.—Dysentery and hypostatic pneumonia.

GROUP IV., CLASS (3).

Seniles who Suffer from Convulsions.

These twelve cases are largely senile patients with epileptiform fits, due to vascular degeneration. It is consequently not surprising that of the total number only two, Nos. 164 and 168, are free from naked-eye atheroma. Of the ten cases with affected vessels the atheroma is slight in two, moderate in four and severe in four.

An almost constant clinical feature of the early stage of the disease in these cases was again mental confusion.

In brain weights, as would be expected a priori, the cases in this class resemble those in class (1) rather than those in class (2), the hemispheres of males varying from 440 to 728 grammes, and of females from 445 to 565 grammes. It is an interesting fact that the three males with the lowest brain weights have all a hereditary history of insanity.

The following three cases are inserted as types. In No. 162 the lesions were cortical and large, in No. 166 they occurred in the basal ganglia, and in No. 171 they were small and superficial, and occurred in the cortex of the base of the brain. In all these cases the symptomatology bears an interesting relationship to the lesions existing.

Case 162.

Admitted December 2, 1898. Died January 17, 1900. Female, aged 65, widow. No family history.

History.—Intemperate. Symptoms for three months. Is restless and confused, and sometimes excited and noisy. Wanders about aimlessly.

Course.—Rambling and incoherent. Memory very defective. Is lost, and wet in her habits. Had several epileptiform convulsions. Was restless and noisy at night, and suffered from well-marked dementia. Had several successions of left-sided convulsive attacks, attended by temporary paresis.

Dura and S.D.—Natural. Excess of fluid. Pia.—Diffusely opaque. S.A.—Excess of fluid. Vents. L.—Dilated. IV.—

Natural. Vessels.—Slightly atheromatous. There were superficial softenings in the right Rolandic area, and also a recent thrombosis of the artery of the left collateral fissure. Right hemisphere, unstripped, 465; left hemisphere, unstripped, 495. Right hemisphere, stripped, 435.

Cause of death.—Malignant disease of the ovaries.

Case 166.

Admitted March 12, 1901. Died August 11, 1901. Female, aged 59, widow. No family history.

History.—A paralytic fit three years ago. Has suffered from debility for fifteen months, and slept badly for twelve months. For three months has been depressed, and lost her memory. Is sullen, dull, and depressed. Pays no attention to questions, but simply stares. Is very restless and troublesome.

Course.—Slow reaction to questions. Memory defective Is incoherent and lost, and thinks that people are against her. Takes no interest in her surroundings, and cries when spoken to. Twelve days before her death had a bilateral convulsion, followed by paralysis of the left side. Four days before death could be roused, and said that she was better, but was otherwise practically unconscious.

Dura and S.D.—Natural. Considerable excess of fluid. Pia.—Moderate fronto-parietal milkiness. Considerable general thickening. Strips very readily. S.A.—Moderate excess of fluid. Vents. L.—Dilated. IV.—A few granulations in the lateral sacs. Vessels.—Basal vessels dilated and atheromatous. Considerable calcareous atheroma of all the cortical arteries. There were small multiple softenings in the basal ganglia. Right hemisphere, unstripped, 515; left hemisphere, unstripped, 510. Right hemisphere, stripped, 470; left hemisphere, stripped, 465.

Cause of Death.—Cardiac failure. Gross vascular degeneration, with multiple fusiform aneurysmal dilatations of the mesenteric arteries.

Case 171.

Admitted December 28, 1899. Died March 25, 1900. Male, aged 61 years, married. No family history.

History.—Certified for eighteen months. Frequently has fits. Quite lost. Very violent after fits, and threatens to kill his relatives.

Course.—Vacant, depressed, restless, incoherent, lost. Slow

mental reaction. At times wet in his habits. Has about one fit a week.

Dura and S.D.—Natural. Excess of fluid. Thin brownish film on the base. Pia.—Moderate parietal opacity. Considerable thickening. Strips very readily. S.A.—Excess of fluid. Vents. L.—Dilated. IV.—A few granulations in the lateral sacs. Vessels.—Somewhat atheromatous. The brain shows numerous superficial basal softenings. Right hemisphere, unstripped, 575; left hemisphere, unstripped, 595. Left hemisphere, stripped, 565. Cause of Death.—Pneumonia.

The Heredity of Insanity in Group IV.

Of the thirty-seven cases in this group family histories were available in fourteen instances, and of these eight, or 57.1 per cent., showed a hereditary history of insanity.

Pathological Summary of Group IV.

Class (1).—Six cases. "(?) Recent seniles." Dura thickened or adherent in two cases. One subdural film. S.D.—Excess of fluid in three cases, and great excess in three cases. Pia.—Strips very readily in six cases. S.A.—Excess of fluid in four cases, and great excess in two cases. Vents. L.—Dilated in six cases, and one also granular. IV.—Granular lateral sacs in four cases. Vessels.—Atheroma in four cases.

Class (2).—Nineteen cases. "Chronic seniles." Dura thickened or adherent in eight cases. Three subdural films. S.D.—Excess in eight and great excess in eleven cases. Pia—Strips readily in three, very readily in thirteen, and like a glove in three cases. S.A.—Excess in ten, and great excess in nine cases. Vents. L.—Dilated in fifteen, and granular in four cases. IV.—Granular lateral sacs in thirteen cases. Vessels.—Atheroma in nine cases.

Class (3).—Twelve cases. "Chronic seniles with fits." Dura thickened or adherent in five cases. Subdural films in three cases. S.D.—Excess in three, and great excess in nine cases. Pia.—Strips readily in three, very readily in eight, and like a glove in one case. S.A.—Excess in six, and great excess in six cases. Vents. L.—Dilated in twelve cases. IV.—Granular lateral sacs in eight cases. Vessels.—Atheroma in ten cases.

Total.—Thirty-seven cases. Dura thickened or adherent in 41 per cent. Subdural films in 19 per cent. S.D.—Excess in 100 per cent., namely, moderate in 38 per cent., and great in 62

per cent. Pia.—Abnormal in 100 per cent., namely, strips readily in 16 per cent., very readily in 73 per cent., and like a glove in 11 per cent. S.A.—Excess in 100 per cent., namely, moderate in 54 per cent., and great in 46 per cent. Vents. L.—Dilated in 89 per cent., and granular in 13 per cent. IV.—Granular lateral sacs in 68 per cent. Vessels.—Atheroma in 62 per cent.

Note.—Atheroma occurred in twenty-three (62 per cent.) of the cases; in thirteen (35 per cent.) it was slight; in three (8 per cent.) it was moderate; and in seven (19 per cent.) it was severe.

GROUP V.

Cases of Gross Dementia.

The cases in this group are as follows:—

(1) (?) Recent senile cases	• •		• •	• •		٠.	7
(2) Chronic senile cases	• •	••	• •	••	• •		20
						•	27

Of the twenty-seven senile cases in this group no less than twenty-five are above the average age of 57 years, the other two cases being aged 53 and 55 years respectively. The group, as a whole, calls for no remark.

GROUP V., CLASS (1).

(?) Recent Senile Cases.

Of the seven (?) recent senile cases in this class, the cerebral vessels are natural in three and atheromatous in four, one of these being moderately and three being severely affected. All these four patients were above the average age.

In all the cases in the class the constant clinical feature on admission was extremely marked mental confusion. Case 176, female, aged 60 years, and Case 179, male, aged 75 years, are inserted as illustrative examples.

It is an interesting fact that, of the three cases without naked-eye atheroma, two were females, aged, respectively, 70 and 76 years, with very low brain weights, the hemispheres weighing from 365 to 430 grammes each only; and the third was a male with marked asymmetry of the hemispheres, the respective weights being 580 in the case of the right, and 505 in the case of the left (see page 486).

Case 176.

Admitted June 1, 1899. Died February 15, 1900. Female, aged 60, married. No family history.

History.—Symptoms for two months. Conversation rambling and irrational. Strange in manner and destructive and dirty in her habits. Attacks the other patients.

Course.—Confused and irrational. Memory very defective. Dirty in her habits and at death was quite dull and lost.

Dura and S.D.—Natural. Excess of fluid. Pia.—Parietal opacity. Extreme general thickening. Strips like a glove. S.A.—Excess of fluid. Vents. L.—Dilated. IV.—Natural. Vessels.—Cortical arteries extremely calcareous. A softening in the left inferior parietal lobule. The brain shows marked general and extreme prefrontal wasting. Right hemisphere, unstripped, 500; left hemisphere, unstripped, 495. Left hemisphere, stripped, 455.

Cause of death.—Gangrene of the leg.

Case 179.

Admitted February 3, 1899. Died March 8, 1900. Male, aged 75, widower. No family history.

History.—Violent, and says that he cannot help it. Strange in manner.

Course.—Strange, excitable, violent and threatening. Lost and confused. Memory impaired. Habits defective. Finally feeble, shaky and grossly demented.

Dura and S.D.—Slightly thickened. Marked excess of fluid. Thin subdural membrane throughout. Pia.—Opaque over the anterior two-thirds of the brain. Considerably thickened. Strips like a glove. This is rather less marked in the right hemisphere than in the left. S.A.—Excess of fluid. Vents. L.—Markedly dilated. Somewhat granular. IV.—Granulations in the lateral sacs. Vessels.—Atheromatous throughout. There is marked wasting in the left hemisphere, especially in the prefrontal region. On the right side it exists chiefly in the prefrontal region. There is a great difference in appearance between the two hemispheres. Right hemisphere, unstripped, 530; left hemisphere, unstripped, 540. Right hemisphere, stripped, 500; left hemisphere, stripped, 510.

Cause of death.—Tuberculosis of the lungs.

GROUP V., CLASS (2).

Chronic Senile Cases.

The cases in this class were on admission of various types, some exhibiting different symptoms-complexe of ordinary non-toxic insanity, and others being in more or less marked stages of mental confusion. All the cases as the dementia progressed passed through the stage of confusion, and, as will be shown later, this period is coincident with, and (the writer thinks he has proved) the consequence of, the development of marked vascular degeneration.

Of the twenty cases there was naked-eye atheroma in sixteen, this being slight in three, moderate in two, and severe in eleven. Of the four cases with apparently natural vessels, the only one with a family history has a marked hereditary history, and is aged 77 years. In the four the hemisphere weights were 390 to 530, and in the sixteen they were 405 to 635 grammes. (See page 486.)

Nos. 198 and 199, possessing such extreme age-limits as 78 and 53 years respectively, are fully referred to as Cases 18 and 19 in Part II. One other case, No. 185, aged 68 years, is cited below.

Case 185.

Admitted July 4, 1900. Died April 17, 1901. Male, aged 68 years, widower. No family history.

History.—Doctor of medicine. Intemperate. Right hemiplegia at the age of 30. Practised his profession till ten years ago, after which he had epileptiform fits till four years ago. His memory began to fail six or seven years ago. He has required a nurse for four and a half years.

Course.—Old right hemiplegia. Morbus cordis. Vascular degeneration. Is restless and fidgety but happy and contented, and has grandiose delusions of a religious nature. Is lost to time and place and unable to attend to his own wants. Recognises strangers as old friends. Gradually became more lost, and wet, and later dirty in his habits. Was finally quite helpless and grossly demented and died rather suddenly from cardiac failure.

Dura and S.D.—Adhesions to the skull-cap in the left frontal region. Enormous excess of fluid. Pia.—Opaque in the fronto-parietal region. Much thickened. Strips like a glove. S.A.—

Considerable excess of fluid. Vents. L.—Markedly dilated and granular. IV.—Granulations in the lateral sacs. Vessels.—Much thickened and atheromatous. An old cyst in the left internal capsule. The brain shows extreme prefrontal and considerable general wasting. Weight of encephalon.—1,315 grammes.

Cause of death.—Cardiac failure. Advanced chronic morbus cordis.

The Heredity of Insanity in Group V.

Of the twenty-seven contained in this group, family histories were available in eight instances, and these showed a hereditary history of insanity in four, or 50 per cent.

Pathological Summary of Group V.

Class (1).—Seven cases. "(?) Recent seniles." Dura thickened or adherent in two cases. One subdural film. S.D.—Excess in three, and great excess in four cases. Pia.—Strips like a glove in seven cases. S.A.—Excess in five cases, and great excess in two cases. Vents. L.—Dilated in seven and granular in three cases. IV.—Granular lateral sacs in four cases. Vessels.—Atheroma in four cases.

Class (2).—Twenty cases. "Chronic seniles." Dura thickened or adherent in eight cases. Subdural films in five cases. S.D.—Excess in eight, and great excess in twelve cases. Pia.—Strips very readily in nine, and like a glove in eleven cases. S.A.—Excess in six, and great excess in fourteen cases. Vents. L.—Dilated in twenty, and granular in four cases. IV.—Granular lateral sacs in eleven cases. Vessels.—Atheroma in sixteen cases.

Total.—Dura thickened or adherent in 37 per cent. Subdural films in 22 per cent. S.D.—Excess in 100 per cent., namely moderate in 41 per cent., and great in 59 per cent. Pia.—Abnormal in 100 per cent., namely, strips very readily in 33 per cent., and like a glove in 67 per cent. S.A.—Excess in 100 per cent., namely, moderate in 41 per cent., and great in 59 per cent. Vent. L.—Dilated in 100 per cent., and granular in 26 per cent. IV.—Granular lateral sacs in 56 per cent. Vessels.—Atheroma in 74 per cent.

Note.—Atheroma occurred in twenty)74 per cent.) of the cases; in four (15 per cent.) it was slight, in three (11 per cent.) it was moderate, and in thirteen (48 per cent.) it was severe.

General Summary of Morbid Appearances.

In the following table is given a general summary, in percentages, of the morbid appearances above described. On examination it will be seen that the morbid changes existing in the 200 cases examined vary directly with the amount of dementia present:—

200 Cases of Insanity.	Group I. (\$3)	Group II. (52)	Group III. (51)	Group IV. (37)	Group .V. (27)
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
$\textbf{\textit{Dura}}: -\!$	9	22	31	41	37
Subdural deposit	6	6	8	19	22
Subdural excess (1) Slight (2) Moderate (3) Great	18 9 9	67 11 56	84 84	100 38 62	100 41 59
Pia-arachnoid strips:— (1) Naturally (2) Rather more readily	67	8	_		
than natural (3) Readily (4) Very readily (5) Like a glove	33 — — —	73 19 —	82 18	16 73 11	 33 67
Sub-arachnoid excess (1) Slight (2) Moderate (3) Great	15 15 —	66 14 52	88 88 	100 54 46	100
Lateral ventricles:— (1) Dilated	15 6	41 4	69 12	89 13	100 26
IV. ventricles:— Granular lateral sacs	27	39	49	68	56

The general pathology of these morbid conditions and their relations to one another will be discussed later (p. 487 et seq.), but it is necessary to refer here to certain morbid appearances not introduced into the table, namely, the nakedeye changes in the cerebral hemispheres. These will be prefaced by a few further details concerning the pia-arachnoid.

. As has been seen in the descriptions of the cases under consideration, in the majority of instances the hemispheres were drained and weighed before and after stripping. The difference between these weights represents the pia-arachnoid and a certain amount of fluid contained in it.

In *Group I.*, in twenty-nine of the thirty-three cases, the average weight of the membrane, &c., per hemisphere is 17 grammes.

In Group II., in fifty of the fifty-two cases, it is 19 grammes.

In Group III., in forty-five of the fifty-one cases, it is 25 grammes.

In Group IV., in thirty-six of the thirty-seven cases, it is 34 grammes.

In Group V., in twenty-five of the twenty-seven cases, it is 35 grammes.

In spite of such apparently fatal factors as differences in the amount of draining and in the ædema of the membranes, the average weights bear a remarkably close relationship to the results in the table given above, and afford an excellent illustration of the ease with which even gross errors are eliminated when an average is made from a sufficient number of cases. As in the table, so in these figures, the difference between Groups I. and II. is not very marked; both these differ considerably from Group III.; and this differs even more from the again similar Groups IV. and V.

Regions of Wasting and Under-Development in Mental Disease.

Wasting.—The regions of the cerebrum in which wasting occurs during the progress of dementia are, approximately, from observation of several hundred cases, as follows¹:—

- (I.) The greatest amount occurs in the prefrontal region (anterior two-thirds or so of the first and second frontal convolutions, including the neighbouring mesial surface, and the anterior third or so of the third frontal convolution).
- (II.) The wasting is next most marked in the remainder of the first and second frontal convolutions. (In dementia paralytica Broca's convolution should as a rule be included here, and II. and III. should follow IV., see pp. 536 and 539.)

¹ In conjunction with this account, see Figs. 6 to 11, Plates II: and III., and Figs. 16 and 17, Plate V.

- (III.) It is perhaps next most marked in the ascending frontal and Broca's convolutions, though this grade should in many cases at least follow (IV.).
- (IV.) It is next most marked in the first temporal convolution and in the superior and inferior parietal lobules.
- (V.) It is least marked in the remainder of the cerebrum (including the orbital surface of the frontal lobes), particularly the inferio-internal aspect of the temporo-sphenoidal lobe and the posterior pole of the hemisphere.

In the experience of the writer exceptions to this general order are invariably due to vascular or traumatic causes, and should, therefore, be excluded from the ordinary and normal wastings of dementia (see also pp. 559-560).

Under-development.—Apart from the necessarily excluded abnormalities of development which are of vascular or traumatic origin, the degree of under-development follows the order given above, at least as regards (I.) and (II.).

A further statement regarding this cannot be made owing to the relatively small number of cases occurring, at any rate in an ordinary asylum, which show a decrease reasonably comparable with the marked wasting which occurs in severe dementia, as it is more usual to find small and simply convoluted cerebra than brains with average but small convolutions.

Relative weights of the cerebral hemispheres in mental disease.—The male encephalon between the ages of 15 and 80 years averages (F. Marchand) 1,400 grammes in weight, and 84 per cent. lie between 1,250 and 1,550 grammes. The female similarly weighs 1,275 grammes, and 91 per cent. lie between 1,100 and 1,450 grammes. The ratio of the conjoined cerebellum and pons to the cerebrum is in the adult 13:87 (Huschke). The cerebral hemispheres thus weigh 609 grammes each in the male, and 554 grammes each in the female; and in the stripped condition about 589 and 534 grammes respectively.

Of the 200 cases above described, which consist of sixtyone males, and 139 females, the weights of the stripped hemispheres are given in fifty-five males and 131 females, or in 186 cases. Owing to their greater brain weight it has been thought desirable to separate the epileptic cases from the remainder, in order to bring this fact into prominence. It is well seen in the following table:—

Weights of Stripped Hemispheres from 186 Cases.

	Males.	Females.
Group I. (33 cases)	Ordinary (4) 535 grs. Epileptic imbeciles (3) 556 ,,	Ordinary (20) 496 gr Epileptic im- beciles (2) 485 ,,
	Total (7) 544 ,,	Total (22) 495 ,
Group II. (52 cases)	Ordinary (5) 498 ,, Epileptics (2) 545 ,,	Ordinary (40) 473 ,, Epileptics (4) 534 ,,
	Total (7) 512 ,,	Total (44) 478 ,
Group III. (51 cases)	Ordinary (12) 549 ,, Epileptics (3) 604 ,,	Ordinary (27) 473 ,. Epileptics (4) 506 ,,
	Total (15) 561 ,,	Total (31) 477 ,
Group IV. (37 cases)	Ordinary (11) 501 ,, Epileptiform	Ordinary (13) 442 ,. Epileptiform
,	cases (7) 510 ,,	cases (5) 458 ,
	Total (18) 505 ,,	Total (18) 446,
Group V. (27 cases)	Total (8) 502 ,,	Total (16) 446 ,
186 of 200	Total 55 males	Total 131 females

In the above table of weights it is probable, at any rate in the first three groups, that the female results, owing to their greater number, are more reliable than the male. A certain value must, however, attach to the results as a whole, for, except in the case of the females in Group I., where the two epileptic imbeciles average less than the other cases, throughout the table the epileptics consistently weigh more than the remainder. From an examination of the table the following facts are elicited. The weights throughout are considerably below the normal average (males 589 and females 534 grammes), even in Group I. where no wasting has occurred, and in Group III. where little or no wasting has occurred. Even in Group III it is doubtful whether the wasting which has occurred is sufficient to entirely

account for the decrease in average weight. On the other hand in Groups IV. and V. such very extreme wasting has occurred that it is difficult to even roughly estimate the original weight of the brains. It is clear, however, that the brains of Group III. have originally possessed an equal, if not a considerably greater, weight than those in Groups I. and II., and this agrees with the results obtained in Part II., which show in the first and second groups a considerable under-development of the cerebral cortex which is in some cases almost as marked as is the wasting in Group IV. In other words, without attaching undue value to the figures, it is probable that the cases in Group III. have fallen from a higher level of development than that at which the cases in Groups I. and II. are stationary. This subject will be referred to more fully in later sections of the paper.

Relative weights of the cerebral hemispheres.—In the normal brain the average difference between the hemispheres is only about 5 grammes (Braune). It will however be seen in the following table, in which the relative weights of the stripped hemispheres in 171 of the 200 cases described above are classified, that whilst the left hemisphere is perhaps a little more frequently lighter than (than heavier than) the right, much greater differences exist in individual cases than in the normal. Certain reasons for these differences will shortly be referred to.

Relative Weights of Hemispheres of 171 Cases.

				Left Hi	AVIER T	HAN I	RIGHT.					
Grammes		1-4	5.9	10-14	15-19	20	25	85	45	70	93	Total.
Group I.		2	4	_	1	_		_	-	_	_	7
Group II.		1	10	3	2	_	_	_	-	-	1	17
Group III.		6	8	1	2	_	_:		_	1	_	18
Group IV.		2	3	4	_	1	1		_	_	_	11
Group V.		1	4	3	_		_	1	1	—		10
Total	•••	12	29	11	5	1	1	1	1	1	1	63

			LE	FT LIGH	TER THA	n Right					L.=R
Grammes.		1-4	5-9	10-14	15-19	20-24	25-29	68	80	Total.	Total.
Group I.	••	3	3	1	•	2	_	_	_	10	4
Group II.	••	4	6	2	3	1	2	_		18	13
Group III.	••	1	9	7	_	1	1	1	_	20	8
Group IV.			8	4	1	2	1	_	_	16	5
Group V.		_	4	3	2	2	2	_	1	14	_
Total		8	30	17	7	8	6	1	1	78	30

The above table shows that considerable differences occur in the weights of the corresponding hemispheres in the insane. It is probable that at any rate in the earlier groups some differences are developmental and not due to wasting, for they occur so equally throughout the groups instead of in the later ones only, and also almost equally in either hemisphere. It will be noticed that more than one-sixth of the total are of equal weight, and that those equal weights are also distributed throughout the groups. It would appear then that an unequal development of the hemispheres is not unusual in cases of mental disease.

When, however, the types of case are taken into consideration, further light is thrown on the question. To avoid fallacies, only those cases are considered in which there is more than 15 grammes difference between the hemispheres. Of these there are 34, the left being heavier than the right in 11, and lighter than the right in 23.

Left hemisphere heavier than right.—Of the eleven cases, four are of vascular origin, three are epileptics, one has a heredity of insanity, and three are chronic or recurrent lunatics without family histories.

Right hemisphere heavier than left.—Of the twenty-three cases, eleven are of vascular origin, three are epileptics, four have heredity of insanity, four are chronic or recurrent lunatics without histories, and one is a recent admission without a history.

Hence of the forty-four cases, no less than fifteen are of

vascular origin, and the preponderance of cases where the left is wasted more than the right is explicable on the greater general frequency of left-sided gross lesions of the cerebrum owing to the more direct course of the left internal Of the fifteen cases of vascular lesion, carotid artery. Groups I. and II. produce one case each with right-sided lesions, and these are both accidental, the former being due to the pressure of a subdural hæmorrhage and the latter to embolism. Of the remaining thirteen, two belong to Group III., three to Group IV., and eight to Group V.

Six of the cases are epileptics, and the epilepsy may be in some cases a precedent, and in others a consequent, for one case belongs to Group I., two to Group II., one to Group III., and two to Group IV.

Of the remaining thirteen cases, family histories exist in five, and in all these there is a heredity of insanity.

Finally, of the eight without family histories, seven are chronic lunatics (two in Group I., two in Group II., one in Group III., one in Group IV., and one in Group V.), and one (Group II.) is a recent admission.

It is hence clear that, as a whole, differences beyond 15 grammes in the weight of the cerebral hemispheres in insanity chiefly depend on vascular causes; and that of the other cases either epilepsy exists, or the family history reveals a heredity of insanity, both of which probably point to a developmental origin for the difference between the weights of the hemispheres.

THE ACTION OF FORMALIN ON THE CEREBRAL HEMISPHERES.

Though the fact has been recorded by several observers. it does not seem to be by any means generally known that the effect of hardening in formalin is to considerably increase the weight of the tissue immersed in it.

Owing to the fact that certain of the brains investigated in Part II. were obtained in the already hardened condition, the writer found it necessary to make a few observations on this subject.

The following weights in grammes of certain of the twenty brains referred to in that part of the present paper show how markedly the weight is affected during the hardening process:—

	Тур	e.				Before hardening.	After hardening.	Twelve months later.
Imbecile, Case 12		••	••	•••	••	520	668	628
Insanity without	lementi	a, Case	13			495	560	534
,, 11	,,	,,,	14			498	560	54 0
,, ,,	,,	,,	15	. • •	• •	488	520	495
Chronic insanity v	vith ma	rked d	em e n	tia, Cas	e 16	503	565	525
,, ,,	,,		,,	,,,	17	445	555	490
Gross dementia, C	ase 18					440	510	480
•	,, 19			• •		347	400	37 0

These figures show that there is no clear relation between the weights before and after hardening, except in the fact that the latter is always the greater. In each case, however, a year after hardening the weight had again decreased. The only obvious explanations of this appearing to be relative differences in the amount of ædema and in the chemical constitution of the brains, the writer requested Mr. Pitt, late laboratory assistant in the chemical department at Claybury, to assist him in settling this question. The following was the result of an experiment:—

A hemisphere was cut into thin strips and placed in a 1,000 cc. measuring-flask. The weight of brain taken was 582 grammes; 5 per cent. formalin was then added to the mark on the flask (25 grammes of Schering's formalin made up to 500 cc. with distilled water), 442 cc. of the solution being required. After hermetically sealing the flask and allowing it to stand for a fortnight, it was opened, and the liquid was drained off, 360 cc. being obtained. 442—360, or 82 cc. of fluid were consequently absorbed by the tissue, which increased in weight to the extent of 82 to 83 grammes.

The hardening fluid was slightly acid in reaction, and of pungent smell, and had a flocculent precipitate suspended in it. This latter was filtered off and the filtrate was distilled to dryness, careful precautions being taken to guard against any loss of H.CHO. S.G. of the distillate 1.001 at 18° C.; S.G. of the 5 per cent. formalin 1.0049 at 18° C.

Conclusion.—A certain amount of H.CHO. was still present in the hardening fluid, and the loss of formalin was relatively inappreciable compared with the 82 cc. of fluid which was absorbed by the tissue. Hence the fluid absorbed was water, and the process of hardening is therefore probably one of hydration, the H.CHO. acting as a watercarrier. This partly, at least, explains the irregular results which occur in different brains, as great differences exist in the amount of water present in them, and presumably the more ædematous the brain the less would be the increase in weight on hardening.

The fairly constant relationship which exists between the preliminary increase in weight on hardening and the decrease a year later suggests that the latter is due to a slow process of dehydration.

DEGENERATION OF THE CEREBRAL VESSELS IN MENTAL DISEASE.

The vascular degeneration present in the 200 cases described is as follows:-

described is as follows.		
	\mathbf{Per}	cent.
Group I.—Average age 38 years, 3 in 33 cases	• •	9
(1) No. 8. Age 67. Severe degeneration in association with	$i\mathbf{th}$	
renal cirrhosis and very gross general arterial degene tion.	ra-	
(2) No. 12. Age 39. Moderate degeneration in association we general arterio capillary fibrosis.	ith	
(3) No. 17. Age 59. Moderate degeneration in association w	ith	
systemic syphilis and general arterial degeneration.		
Group II.—Average age 55 years, 9 in 52 cases		17
(1) 4 in 45 cases and all slight 9 per cent.	.)	
(2) 5 in the class of 7 recent seniles 71 ,,	Ì	
(2 natural, 3 slight, and 2 moderate.)	,	
Group III.—Average age 57 years, 16 in 51 cases		31
(35 natural, 8 slight, 6 moderate, and 2 severe.)		
Group IV.—Average age 68 years, 23 in 37 cases		62
(14 natural, 13 slight, 3 moderate, and 7 severe.)		
Group V.—Average age 70 years, 20 in 27 cases (7 natural, 4 slight, 3 moderate, and 13 severe.)	••	74

It will be seen that the atheroma in the class of recent seniles in Group II., all of whom, judging from their mental conditions, might have rapidly, had they lived, passed on into later groups of cases, is practically identical with that in Group V.

These figures at once suggest that the atheroma may be merely one of the changes occurring in senility, and may have little or no causal relationship to the progress of dementia. The following considerations, however, *conclusively demonstrate that this is not the case, but that whilst atheroma and senility have no necessary relationship to one another, the former and severe dementia are closely related; and it is proposed to show that this relationship is of the nature of cause and effect.

The average age of the 200 patients is 57 years, and the average age of the cases in Groups I. to V. is respectively 38, 55, 57, 68, and 70 years. The percentage below the average age in each group is as follows:—82, 54, 45, 11, and 7 per cent.

Of the cases below the average age of 57 years, there is one example of atheroma in each group:—

Group I.—Age 39. Moderate atheroma. Arterio-capillary fibrosis. (1 in 27.)

Group II.—Age 46. Slight atheroma. Aneurism of aorta. (1 in 28.)

Group III.—Age 48. Moderate atheroma. Renal cirrhosis. (1 in 23.)

Group IV.—Age 53. Slight atheroma only. (1 in 4.) Group V.—Age 55. Slight atheroma only. (1 in 2.)

Hence the first three cases are due to general causes, and the other two are slight, and, consequently, a study of atheroma may safely be made amongst patients above the average age of 57 years.

The percentage above the average age in each group is as follows:—18, 46, 55, 89 and 93 per cent. in Groups I. to V. respectively.

Age and Vascular Degeneration in Relation to the Five Groups of Cases.

		up I. 3).		р II. 2).	Grou (5		Grou (3		Groo	
	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age
Number of and average age of all patients above 57 years	6	67	24	68	28	71	33	69	25	72
Number of and average age of all patients above 57 years, without atheroma	4	68	16	65	13	67	11	69	6	70
Number of and average age of all patients above 57 years, with atheroma	2	63	8	73	15	74	22	69	19	72

A review of the above figures shows that the presence of vascular degeneration is independent of age, as the average age in each group, whether atheroma exists or not, does not vary.

On the other hand the following figures show that the percentage of atheroma increases directly with the amount of dementia present:—

	Group I.	Group II.	Group III,	Group IV.	Group V.
Per cent. of atheroma in patients above 57 years.	(2 in 6)	(8 in 24)	(15 in 28)	(22 in 33)	(19 in 25)
	33 per	33 per	54 per	67 per	76 per
	cent.	cent.	cent.	cent.	cent.

This is still more clearly seen when these figures are analysed.

Group I.—Of the six cases, four are natural. The two cases of atheroma are:—

- (1) Age 67. Very gross general arterial degeneration with renal cirrhosis.
- (2) Aged 59. Systemic syphilis and gross arterial degeneration. Both these cases of atheroma are therefore accidental.

Group II.—Of the twenty-four cases, sixteen are natural. Of the eight cases of atheroma, five occurred in the class of seven recent seniles who would probably, had they lived, have passed on into later groups, and all the others were slight. Group III.—Of the twenty-eight cases, thirteen are natural. Of the fifteen cases of atheroma, eight are slight, five are moderate, and two are severe.

Group IV.—Of the thirty-three cases, eleven are natural. Of the twenty-two cases of atheroma, twelve are slight, three are moderate, and seven are severe.

Group V.—Of the twenty-five cases, six are natural. Of the nineteen cases of atheroma, three are slight, three are moderate, and thirteen are severe. Further analysis of Groups III.-V. is unnecessary (see following discussion).

Hence not only does atheroma become more frequent in the later groups, but it is also more severe, whilst the average age of the cases above the general average age of 57 years remains almost the same in all the groups, whether atheroma exists or not. It is thus evident from the above that dementia is moderate only in degree unless severe vascular degeneration co-exist. This points to a causal relationship between severe atheroma and gross dementia, and, as the latter cannot cause the former, either the two are consequences of another primary cause, or the former in the cause of the latter.

It is proposed to demonstrate that the latter alternative is the correct one, and, in order to bring out this causal relationship, two points must be discussed:—(1) Does severe atheroma exist without gross dementia? and (2) Is there any evidence that in potential gross dementia atheroma exists as a precedent of this condition?

(1) It is common pathological knowledge that gross vascular degeneration (excluding gross lesions) may exist in ordinary sane individuals without the presence of more than the feeble-mindedness of old age and worn out neurones.

Instances of the gross vascular degeneration without severe dementia, in the 200 cases described, have already been referred to, e.g., Group I., No. 12, aged 39, general arterio-capillary fibrosis; No. 8, aged 67, severe general vascular degeneration and renal cirrhosis; and No. 17, aged 59, systemic syphilis and very gross general arterial degeneration; Group II., No. 38, aged 46, aneurism of the thoracic aorta; and Group III., No. 110, aged 48, general arterial degeneration and renal cirrhosis.

The following case of most gross arterial degeneration, in an old man of 91 years, whose mental condition was by no means abnormal considering his age and circumstances, is of importance in this connection:—

Case 201.

Admitted July 19, 1899. Died May 30, 1901. Male, aged 91 years. No family history.

History.—Sight and hearing are much impaired; hence he is depressed and has tried to drown himself, as he is tired of life.

Course.—Is very deaf and nearly blind. Answers questions very well considering his age. Says he tried to kill himself as he had spent all his savings, and had no one to look after him. He had £150 saved thirteen years ago. He felt very miserable, but feels better now. Is quiet and well-behaved. Shortly afterwards he became very depressed and tried to strangle himself with a sheet. Later, was at times very depressed, and at times was noisy at night. He became stone-deaf and nearly blind, and finally was in feeble health and often in bed.

Dura and S.D.—Immensely thickened and opaque. Great excess of fluid. Pia.—Extremely opaque, and thickened over the anterior two-thirds of the brain, except the prefrontal region and beyond two to three inches from the mid-line. Some milkiness extends over the greater part of both hemispheres. The marked opacity extends downwards on the median aspect as far as the corpus callosum. There are well-marked mid-line prefrontal adhesions below the falx cerebri. The pia strips like a glove in the fronto-parietal region, but there is marked decortication on stripping in the postero-inferior aspect, including the occipital and temporo-sphenoidal lobes. S.A.—There is a little excess in the fronto-parietal region. Vents. L.—Considerably dilated and slightly granular. III.—Slightly granular. IV.—Very granular, especially in the roof and lateral sacs. The granulation is least marked in the calamus. The basal vessels are very atheromatous. The vessels are immensely thickened and opaque. In the left hemisphere a recent softening exists in the distribution of the occipital and collateral arteries, and extends as deep as the posterior horn of the ventricle. The brain, as a whole, is, without a history, almost indistinguishable from that of an advanced chronic case of dementia paralytica, excepting in the relative absence of wasting. Weight of encephalon, 1,365 grammes. Right hemisphere, unstripped, 550 grammes; left hemisphere. unstripped, 525 grammes (see Plate III., fig. 13. Right hemisphere,

stripped, 485 grammes (Plate III., fig. 12). The remaining organs are in very good condition for a man of 91.

Cause of death.—Acute peritonitis, following chronic local peritonitis, due to swallowing a fish bone, which had perforated the bowel.

The right and left hemispheres of this case are shown on Plate III., figs. 12 and 13. It will be seen that, compared with the hemisphere of Case 20 of Part II., there is relatively little wasting, and the prefrontal region shows a marked contrast in the two brains, though in similar sites numerous small areas of decortication exist in the two hemispheres. To the naked eye the brain, as a whole, presented many features in common with dementia paralytica, but differed in the relative absence of wasting and in the very chronic and dense thickening of the dura and pia, which had gone far towards replacing the tissue lost by wasting of the cerebrum. The right pia-arachnoid, for example, weighed 65 grammes.

Microscopically the cortex of this case, when examined by a competent independent observer who did not know whence it was derived, was stated to be probably from a fairly advanced case of chronic dementia paralytica. This case will be referred to later in the section on dementia paralytica. (See also figs. 14 and 15, which illustrate the microscopic appearances of the pia-arachnoid and cortex cerebri in this case.)

(2) In Group II. the class of seven recent seniles includes five of the eight cases of atheroma, which occur in the twenty-four patients over 57 years of age. It is slight in three of the five, and moderate in two, which gives a percentage of 71, practically that of the cases in Group V. The two cases of the seven with no naked-eye atheroma had been in the asylum 3½ and 11½ months respectively; the first, No. 47, would probably have gone home, and the second, No. 51, would have probably become a chronic senile case. Of the five with atheroma, all, had they lived, judging from their mental condition whilst under observation and from the rarity of atheroma in the non-demented chronic and recurrent senile cases of the group, would very probably have rapidly passed into Groups IV. or V.

Summary and conclusion.—The evidence in favour of a causal relationship between severe vascular degeneration and gross dementia may be summed up as follows:—

- (1) Simple senility is not necessarily associated with gross degeneration of the cerebral vessels.
- (2) In the insane gross degeneration of the cerebral vessels may exist without any dementia.
- (3) Dementia, except in rare cases (see below), does not progress beyond a moderate stage if gross degeneration of the cerebral vessels does not co-exist.
- (4) In the 200 cases described above, the percentage amount and also the severity of naked-eye degeneration of the cerebral vessels varies directly with the degree of dementia present.
- (5) Severe vascular degeneration occurs before the development of gross dementia. In recent senile cases, with the mildest dementia, who, had they lived, would on clinical grounds have been expected to develop gross dementia, the percentage of naked-eye atheroma is as great as it is in Groups IV. and V. On the other hand, in chronic and recurrent senile cases with mild dementia only, naked-eye vascular degeneration is rarely present, and is then relatively slight.

Hence in a cerebrum which has begun to break down, or where degeneration has passed to the "moderate" stage (Group III.), the presence or incidence of gross vascular degeneration will cause rapid progress of the neuronic degeneration with gross dementia.

The effect of severe vascular degeneration, in thus developing gross dementia out of moderate, though it is powerless to cause more than the feeble-mindedness of old age in non-degenerative cortical neurones, is probably produced:—

- (1) By deficient nutrition of the degenerating cortical neurones.
- (2) By consequent secondary local auto-intoxication, owing to incomplete removal of the products of metabolism and of degeneration.

It is not intended by the above to suggest that gross dementia cannot occur without previous gross and macro-

scopic vascular degeneration, but simply that the latter will cause the former when neuronic degeneration has begun. In all the adult cases of gross dementia, however, which have been examined microscopically by the writer and in which naked-eye atheroma was not present, considerable affection of the smaller cortical vessels existed. An example of this type of case (No. 199) is detailed as Case 19 in the second part of the paper. As will be seen in the notes of this case, the clinical characters strongly suggest the existence of dementia These cases serve as a half-way house to the latter disease and are often only differentiated by pathological study. The probable cause is premature senility of the cortical neurones, and the exact analogue of such cases is seen in the (chronic) variety (e.g., Case 209, page 526) of juvenile dementia paralytica which occurs in distinct imbeciles and in which vascular changes are often relatively In other words, primary neuronic retrogression is the chief condition present, and, whilst in the cases under consideration it occurs after middle life as a premature senility and is associated with considerable vascular affection, in the juvenile cases it is brought about before adult life is reached and is associated with relatively little vascular change. It is not improbable that in certain chronic juvenile cases the neuronic durability may be so deficient that the grossest dementia may supervene without the intervention of 'congenital' syphilis (see note, page 519), in which case the exact homologue of the above-mentioned adult group would The writer is aware that it might be argued that in exist. all such cases it is impossible to prove the absence of syphilis, but he is nevertheless convinced that a rare group exists, whatever the hereditary, &c., cause may be, which is characterised by a remarkably deficient durability of the highest cortical neurones, and in which in juvenile patients vascular changes are practically absent. He also thinks that in this group the influence of syphilis may be excluded, except in so far as it may possibly act as a devitalising factor, in the same way in which phthisis, alcohol, &c., in the parents may lead to the production of degenerate offspring.

Ordinary gross dementia and dementia paralytica.—In

the section on dementia paralytica the opinion will be advanced that this disease is in many respects analogous to the gross dementia of many senile lunatics, but differs in special points of etiology. It will be stated that dementia paralytica occurs in syphilised potential or actual lunatics of those types in which the cortical neurones are prone to degeneration (i.e., the types of lunatics who become demented, not those who do not develop dementia). Whilst gross vascular degeneration when it occurs in senile cases is a natural process of decay with deficient power of repair (this being usually carried out by the deposition of lime salts), on the other hand in the syphilised lunatics of the types referred to, the vascular and neuroglial reparative proliferation which follows the extensive vascular, &c., injury produced by the slow and insidious action of the syphilitic virus is extreme and progressive, and gross dementia more or less rapidly supervenes. Thus, in dementia paralytica, as will be shown, hereditarily deficient neuronic durability is the primary cause of this variety of mental disease, as in all other cases of dementia; and the vascular and neuroglial changes (which are largely of the nature of scar tissue), with their secondary autotoxic sequelæ, and consequent complex vicious circle of events, are the cause of the progress of the case towards gross dementia, certain para-syphilitic symptoms, which belong to the sphere of neurology rather than to that of alienism, co-existing.

It is usually unwise to push an analogy too far, but it is, perhaps, worth while to here draw attention to the numerous senile cases who suffer from epileptiform convulsions of vascular origin, from which they frequently, in a day or two, completely recover, and who are included in a separate class in Group IV.

THE PATHOLOGY OF DEMENTIA.

As has been shown, the morbid appearances inside the skull-cap, which occur in many cases of insanity, namely, chronic degeneration of the dura mater, excess of intracranial fluid, chronic thickening of the pia-arachnoid, &c., are the macroscopic equivalents of, and vary in degree with,

the amount of dementia present, and are otherwise independent of the duration of the insanity. These morbid appearances are all especially evident in dementia paralytica, which, as is suggested in a later part of the paper, is a progressive dementia occurring in the syphilised actual or potential subjects of those types of mental disease in which the cortical neurones are of deficient durability, and are consequently prone to degeneration.

These morbid appearances are the physiological results of the loss of cerebral substance caused by the neuronic degeneration which is the physical expression of dementia reacting on the mechanical conditions existing within the skull-cap. The skull is a closed bony chamber, and were the dementia ever so slow in its progress, replacement of the lost cerebral tissue could not well be fully performed by a chronic hypertrophy in the inner wall of the skull-cap and the cerebral membranes. In consequence, however, of the progress of dementia being relatively rapid, the cerebral membranes, especially the pia-arachnoid, make a hopeless attempt at the formation or replacement of scar tissue, and what cannot be filled in in this way is replaced by cerebro-spinal fluid. Under normal conditions the subdural fluid is minimal in amount. Under these altered conditions, the excess of fluid interferes with the normal relations between the dura mater and the pia-arachnoid. The intracranial fluid of dementia paralytica has been shown by Halliburton and Mott to contain cholin and nucleo-proteid, and to be deficient in reducing substances; and it is probably abnormal also in certain cases of chronic insanity. The consequence, especially in the regions, namely, the anterior and middle fossæ, &c., where stagnation of cerebro-spinal fluid is likely to occur, is a chronic degeneration of the dura mater, resulting in a roughening of its surface, &c. Inside the ventricles also a similar morbid condition develops, namely, granularity of the ependyma. This also occurs chiefly in the regions most subject to stagnation of the cerebro-spinal fluid, namely, in the lateral ventricles behind the foramina of Munro, and in the lateral sacs and calamus or lower half of the fourth ventricle. Granularity of the lateral sacs of the

fourth ventricle is common even in cases of insanity with little or no dementia, and is probably the homologue of the usual proliferative condition of the ependyma of the central canal of the spinal cord in adults, aggravated by contact with abnormal cerebro-spinal fluid. In severe dementia it may also occur on each side of the mid-line in the upper half of the lozenge. When, however, the neuronic degeneration is very acute, as in dementia paralytica, granularity also exists in the lower half of the fourth ventricle below the foramina of Majendie, and this affords one of the most characteristic naked-eye signs of the disease. Even when, as frequently happens in dementia paralytica, the granularity is generally diffused throughout the fourth ventricle, it is nearly always most marked in the lower half of the floor.

As has been shown above, the degree of cerebral wasting varies directly with the degree of dementia present. This occurs in spite of the fact that at the time of death a complete removal of the products of neuronic degeneration has not, in at least many cases, occurred. The latter is particularly the case in fulminating dementia paralytica (see Cases 212-215, pp. 536-7), where the amount of wasting is relatively little compared with that in advanced chronic examples of the disease. In ordinary insanity, on the other hand, the process is slower as a rule and the waste products are so largely removed at the time of death that the gross macroscopic wasting is for practical purposes proportional to the amount of dementia.

THE PATHOLOGY OF SUBDURAL DEPOSITS.

Subdural deposits are probably in nearly all non-traumatic cases secondary to the abnormal intracranial conditions just described.

The most important factor in the production of these deposits appears to be the excess of abnormal intracranial fluid or hydrops ex vacuo which occurs in dementia, with the consequences of this, which have been referred to above.

The deposits may be grouped into two classes:—

(1) Thin films, probably due to deposition of abnormal

contents of the cerebro-spinal fluid on the degenerate dura mater. The films may be more or less organised. When this latter has occurred it is common to find larger or smaller hæmorrhages lying between the film and either the dura or the pia-arachnoid, from either of which membranes the blood may have been effused. These films readily strip from both the dura and the pia, and on reflecting the dura mater they may remain on it or on the pia, according, apparently, to whether the hæmorrhages have arisen from the former or the latter. The hæmorrhages may be recent or old, in which latter case the films may be more or less rusty in colour. It is frequent also to find several superimposed films of different dates. The films again appear in many cases to be primarily hæmorrhagic in nature, and may arise from either the dura or the pia, and in many cases small hæmorrhages exist in the substance of the latter membrane.

These films are the direct results of the abnormal intracranial conditions described above, and their frequency increases with the degree of dementia present. Many are of very recent date, and it is the opinion of the writer that they not unfrequently arise during the alteration in the intracranial blood-content which occurs at death (see p. 498).

(2) Larger or smaller effusions of blood into the subdural space, usually or always arising from rupture of pial veins, and frequently from a vein joining the great anastomotic vein to the lateral sinus.

These hæmorrhages are especially frequent in dementia paralytica, in which the liability to blood-effusions is increased by the epileptiform convulsions, which are an almost constant symptom of the disease, and which necessarily cause considerable alterations in intracranial tension; and the same remark applies also to certain of the insanities which are associated with similar convulsions.

If the effusion be large and the excess of intracranial fluid slight, as in Case 2, the patient will show pressure symptoms, or he may die suddenly as in Case 210 (p. 527). If the excess of intracranial fluid be considerable, to a large extent the site of the blood will depend on gravity, and also

on the roughening of the dura, for under normal circumstances such blood should be largely or entirely flushed out by the cerebro-spinal fluid. If the effusion be large or occur in successively small quantities, the blood, as a rule, clots in situ, say, on the vertex or in one of the middle fossæ. The effusion very rarely extends below the tentorium. The writer has only seen one case in which this occurred.

The frequency with which no symptoms follow the effusion is undoubtedly due to the excess of intracranial fluid, which by escaping through the foramen magnum allows space for the effusion without any increase in intracranial tension. The result if the patient recovers from the immediate effusion is a deposition of semi-organised membranes, or cakes of blood, which in many cases contain semi-fluid contents, or even of calcareous masses.

Frequency of subdural deposits.—According to Bevan Lewis subdural deposits occur in 5.2 per cent. of all cases of insanity. Wiglesworth gives the higher percentage of 8.47. Ford Robertson, from an examination of 290 cases of insanity, has recently reported a percentage of 25.5, and has also stated that a degenerative condition of the dura mater exists in another 25 per cent. of these cases.

From the records of the first 1,626 autopsies performed at Claybury, the writer has found a percentage of 9.76 in the males, and 5.54 in the females, or 7.75 in the whole of the cases. This is probably too low, for a considerable variation exists in the percentage at different periods, and this appears to be largely due to the personal equations of the different observers.

In the 200 cases described above, none of which are cases of dementia paralytica, subdural deposits occurred in 6 per cent. in Groups I. and II., in 8 per cent. in Group III., in 19 per cent. in Group IV., and in 22 per cent. in Group V. The great preponderance which occurs in Groups IV. and V. is an important confirmation of the views of the writer, which have been expressed above on the pathology of these deposits. If the 200 cases be taken in toto, subdural deposits occurred in 11 per cent., which, as the patients were largely of the female sex, agrees with the results given in the table below.

The following table, which includes the above 200 cases, but not any of the previous 1,626, gives the percentage of subdural deposits personally observed by the writer during the first 500 post-mortem examinations which he performed at Claybury:—

	A		SUBDURAL DEPOSIT.					
	AUTOPSIES.		Old.	Recent	Tot	al		
Males {	Ordinary insanity Dementia paralytica	133	14 12	14 13	28 (21· 25 (29·	1%) 4%)		
	Total	218	26	27	53 (24	3%)		
Females $\{$	Ordinary insanity Dementia paralytica	244 38	19 2	11 2	30 (12· 4 (10·	3%) 5%)		
	Total	282	21	13	34 (12	1%)		
	Total	500	47	40	87 (17	4%)		

THE EFFECT OF GRAVITY ON THE INTRACRANIAL CONTENTS OF THE CADAVER.

At death a rapid change occurs in the position of the blood contained in the cranium, that in the arteries decreasing in quantity and that in the veins increasing, the total amount being approximately or exactly the same. This has already been stated by the writer to be a probable cause of many of the recent subdural films occurring in certain of the insane in whom morbid states, particularly of the dura mater, exist, for such an accident is, under these circumstances, probable on physical grounds. That this blood exchange actually does occur will be clear from the experiments contained in the present section.

That, as suggested by Hill, a considerable amount of blood is held up in this way in the veins and sinuses of the cranium, which would escape on opening the skull-cap in a position in which gravity can act, seems hardly to require proof in view of the important researches which have during the past few years been carried out by this painstaking and experienced physiologist. In view, however, of the opinions expressed in the recent work by Ford Robertson on the "Pathology of Mental Diseases," this is not the case, and

the writer of the present paper has consequently put the question to experimental proof. The following is the statement referred to (p. 313):—"Hill maintains that the whole blood-content of the brain may change at the moment that the pathologist opens the skull, in accordance with the direction in which gravity is permitted to act. I scarcely think that this statement is in accord with the general experience of pathologists. I have never myself observed evidence of such changes occurring to any important extent. It has not been my experience that, on opening the skull and reflecting the dura, an anæmic brain can be made a congested one by lowering the head of the cadaver, or that a congested brain can be made anæmic by raising it above the level of the trunk. It would indeed be very surprising if such extreme and rapid alterations could occur, for by the time that autopsies are commonly made the blood in the vessels has generally undergone more or less extensive clotting."

The above quotation is sufficiently clear to render further remarks on the point under consideration unnecessary. Certain preliminary observations will first be referred to, and then twenty careful experiments will be described, which prove that Hill is correct in his hypothesis, and which indirectly afford the strongest support to the Monro-Kellie doctrine.

The following observations are deserving of attention:—

- (1) The cranium was carefully sawn partly through, and was then suddenly cracked with a chisel and hammer; an immediate inrush of air occurred with a sound audible all over the room.
- (2) Two trephine holes were made over the frontal eminences with the head raised on a block, and the dura was opened; the cerebrum at once sank down, and 25 cc. of water were introduced into the vacant space from a burette.
- (3) Two trephine holes were made each midway between the parietal eminences and the mid-line, the sites of operation being kept the most dependent part of the body. On opening the dura nothing happened; on raising the trephine holes above the level of the head and body, the cerebrum

sank, and 21 cc. of water were introduced into the vacant space by means of a burette.

(4) The following experiment, owing to an accidental complication, is also of importance. Similar parietal trephine holes to the last were made with the head raised, and a third midway between them over the superior longitudinal sinus. The last was opened under water, and, contrary to expectation (see Expts. 15-20), only 7 cc. of water entered. On opening the dura in the other trephine holes a large recent cake of blood became visible in each subdural space. This clot, on opening the cranium, was found to weigh 205 grammes, and there was also a considerable quantity of fluid blood in the subdural space. This accidental complication, which caused some increase of intracranial tension and thus pressed on the veins and sinuses, is, in view of the experiments to be described, of extreme importance.

An account will now be given of the twenty experiments which have been carried out. These will be divided into three groups:—(1) In eight cases trephine holes were made over the frontal eminences; (2) in six they were made on each side midway between the parietal eminences and the mid-line; and (3) in six, two similar trephine holes were made to the last, and a third in the mid-line between them over the superior longitudinal sinus.

In the description of the cases the type of case is referred to under one of the five groups already described in a previous section of the paper, or under the name dementia paralytica.

It is perhaps hardly necessary to state that the twenty cases under consideration have been used for the present purpose alone, and are not included in other sections of the paper.

- (I.) Frontal trephine holes.—The body was in the usual position on the post-mortem table, with the head slightly raised by means of a block under the neck, and the trephine holes consequently at the highest point.
- (1) Female, aged 43. Group III. Twelve hours in the cold chamber. Body opened, 15 cc. of water admitted.

- (2) Female, aged 41. Dementia paralytica. Two and a half hours after death at the temperature of the *post-mortem* room. Body opened, 18-2 cc. of water admitted.
- (3) Female, aged 67. Group III. Twenty-four hours in the cold chamber. Body unopened, 25.5 cc. of water admitted.
- (4) Female, aged 55. Group II. Forty hours in the cold chamber. Body unopened, 27 cc. of water admitted, and ten minutes later another 11 cc.
- (5) Female, aged 39. Group II. Nine hours after death at the temperature of the *post-mortem* room. Body opened, 23 cc. of water admitted.
- (6) Female, aged 54. Dementia paralytica. Eight hours after death at the temperature of the *post-mortem* room. Body opened, 21 cc. of water admitted.
- (7) Female, aged 62. Group V. Fourteen hours after death at the temperature of the *post-mortem* room. Body unopened, 23 cc. of water admitted.
- (8) Female, aged 80. Group IV. Twenty-four hours in the cold chamber. Body unopened, 26.5 cc. of water admitted.

In these cases all grades of dementia and also dementia paralytica are represented; the ages varied from 39 to 80 years; some bodies had been opened and others had not; and some had been lying in the post-mortem room at the ordinary temperature for from $2\frac{1}{2}$ to 14 hours, whilst others had been in the cold chamber for from 12 to 40 hours. These factors did not affect the result. The amount of blood displaced varied from 15 to 27 cc., the average being 22.4 cc.

- (II.) Parietal trephine holes.—The body in these experiments was kept semi-recumbent by a towel behind the neck, which was held by an assistant sitting in front of the corpse, and the trephine holes were again the highest point of the body.
- (9) Male, aged 63. Group IV. Six hours after death at the ordinary temperature of the *post-mortem* room. Body partly opened, 21 cc. of water admitted.
- (10) Male, aged 37. Dementia paralytica. Twenty hours in the cold chamber. Body unopened, 17 cc. of water admitted.
- (11) Female, aged 74. Group IV. Three hours after death at the temperature of the *post-mortem* room. Body unopened, 28 cc. of water admitted.

- (12) Female, aged 34. Group III. Twelve hours after death at the temperature of the *post-mortem* room. Body unopened, 19 cc. of water admitted.
- (13) Female, aged 81. Group IV. Five hours after death at the temperature of the *post-mortem* room. Body unopened, 21 cc. of water admitted.
- (14) Female, aged 45. Group III. Two hours after death at the temperature of *post-mortem* room. Body unopened, 25 cc. of water admitted.

In these cases, again, different degrees of dementia existed, and also dementia paralytica; the ages varied from 34 to 81 years; and the bodies had been lying at the temperature of the post-mortem room for from two to twelve hours, and one had been in the cold chamber for twenty hours. The result was not appreciably affected by any of these factors. The amount of blood displaced varied from 17 to 28 cc., the average being 21.8 cc., almost that of the first series of experiments, as would a priori be expected if the results were to be reliable.

Hence, when the skull-cap of the cadaver is opened, and the dura incised, about 22 cc. of blood at once escapes from the veins and sinuses of the skull. This fact is finally proved by the following series of experiments, without which it might be argued that the space was provided by escape of subdural fluid through the foramen magnum, although the constancy of the result in all cases (whether much or little subdural fluid is present), would in itself be a contrary argument.

(III.) Parietal trephine holes, with a central trephine hole over the superior longitudinal sinus.—The body was in the same position as in the last series of experiments. The three trephine holes were filled with water, and the superior longitudinal sinus was then carefully opened and fluid was allowed to enter, which in each case it did at the rate of some cc.'s a second. The cases are divided into two preliminary and four later experiments. In the first two, after 110 and 100 cc. of water had been respectively introduced, the flow of fluid was stopped, and the dura in the lateral holes was incised under water and fluid was allowed to

enter. In the remaining four, fluid was admitted into the superior longitudinal sinus until a constant rate was maintained, and the head was then kept full by constant flow, whilst the dura was opened under water in each of the other trephine holes.

- (15) Male, aged 78. Group IV. Ten hours in the cold chamber. Body unopened. 110 cc. of water admitted into the superior longitudinal sinus. The lateral holes were then opened under water and 7 cc. of fluid entered the subdural space.
- (16) Male, aged 64. Group IV. Twenty hours in the cold chamber. Body unopened. 100 cc. of water admitted into the superior longitudinal sinus. The lateral holes were then opened under water and 6 cc. of fluid entered the subdural space.

In these two cases the superior longitudinal sinus was allowed to run dry, and this fact accounts, as will be seen presently, for the entry of 7 and 6 cc. of fluid respectively into the subdural space.

- (17) Male, aged 31. Group III. Nineteen hours in the cold chamber. Body unopened. 1,100 cc. of fluid were admitted into the superior longitudinal sinus and then a constant flow of about 1 cc. per second was maintained. On opening the dura in the lateral holes, the water in the holes became depressed a little, 1 to 2 cc. apparently entering the subdural space. On opening the head afterwards, the membranes and sinuses and the inner table of the skull were washed perfectly free from blood.
- (18) Male, aged 31. Groups I. to II. Twelve hours after death at the ordinary temperature of the post-mortem room. Body unopened. 530 cc. of fluid were admitted into the superior longitudinal sinus and a constant flow was maintained. On opening the dura in the lateral trephine holes, no depression of the water in these occurred. On laying the body down on the floor nearly half a pint of sanguineous fluid escaped from the central trephine hole.
- (19) Male, aged 48. Dementia paralytica. Seven hours after death at the ordinary temperature of the post-mortem room. Body unopened. 1,050 cc. of water were admitted into the superior longitudinal sinus, and then a constant flow of 1 cc. per second was maintained. On opening the dura in the lateral trephine holes, no depression of the water contained in them

occurred. On laying the body down on the floor, 220 cc. of sanguineous fluid escaped and then a slow syphoning continued from the visibly distended jugulars.

(20) Female, aged 56. Group IV. Eight hours after death at the ordinary temperature of the post-mortem room. Body unopened. 900 cc. of fluid were admitted into the superior longitudinal sinus, and then a constant flow of about 1 cc. per second was maintained. On opening the dura in the lateral trephine holes, a slight depression (1 to 2 cc.) of the water in these occurred. On opening the cranium afterwards, the membranes and sinuses, and the inner table of the skull, were found to be washed perfectly free from blood.

In these cases, again, different degrees of dementia and also dementia paralytica existed; the ages varied from 31 to 56 years; and the experiments were performed seven to twelve hours after death, with the bodies at the ordinary temperature of the *post-mortem* room, and in one case after the body had been nineteen hours in the cold chamber. The results were not affected by any of these factors.

The above experiments prove that the blood content of the cranium at once decreases by about 22 cc. when the skull-cap and dura are opened and gravity is permitted to act. As is illustrated by experiment 4, a further slow escape continues to take place. The result is not affected by the degree or type of dementia present, by the age of the patient, by the time after death at which the experiments are performed, or by the temperature at which the body is kept after death has occurred. It is also an interesting fact that as much as 1,100 cc. of water can, by the action of gravity, be rapidly introduced into the general venous system through the superior longitudinal sinus many hours after death.

It is clear from the above experiments, as was stated at the commencement of the section, that the site of part of the intracranial blood changes from the arterial to the venous side at death, and hence the writer is justified in thinking that many of the recent subdural films found in the insane may occur at the time of death, during, and as a result of, the changes in local intracranial tension which necessarily occur owing to this blood exchange. THE INFLUENCE OF HEREDITY ON THE DEVELOPMENT OF MENTAL DISEASE.

The following account of the hereditary taint of insanity in the 200 cases described, is largely based on the Claybury records, and the percentages given are undoubtedly too low, as frequent interviews with the different friends and relatives for the purpose of careful and persistent search for information enables many facts to be elicited which at an ordinary history interview could not be obtained. It may hence be taken for granted that the following is a description of the more obvious and gross forms of hereditary taint only. As however the different factors are constant throughout, the results are of considerable relative value.

Group I.—Of the thirty-three cases in this group histories were obtained in fourteen. In class 1 (various) one negative statement was recorded; in class 2 (recurrent seniles) there were no histories; in class 3 (a) (hysterics), there were one positive, of several mild recurrent cases, and one negative; in class 3 (b) (excited) there were again one positive and one negative; in class 3 (c) (ditto with delusions) there were one positive and three negatives; whilst in class 4 (imbeciles) there were four positive and one negative, the last being a case of secondary amentia. Of the total fourteen, there were seven positive and seven negative, or 50 per cent. of heredity. In the combined classes 1-3 there was a heredity of 33 per cent., and in class 4 of 80 per cent. These percentages, though of little value owing to the small number of histories, are at least highly suggestive when the types of case are taken into consideration.

Group II.—Of the fifty-two cases in this group, histories were available in twenty-six. In class 1 (gross lesions of the right hemisphere) there were two negative statements; in class 2 (mental confusion) there were one positive and three negative; in class 3 (a) (recent seniles) there were three positive and two negative; in class 3 (b) (recurrent seniles) there were four positive; in class 3 (c) (chronic seniles) there were one positive and one negative; in class 4 (chronic excited adults) there were no histories; in class 5 (chronic delusional adults) there were three positive and one negative; and finally in class 6 (epileptics) there were three positive and two negative. Of the total twenty-six histories there were fifteen positive and eleven negative, or 57.7

per cent., and the distribution of the heredity in the different classes is again highly suggestive.

Group III.—Of the fifty-one cases in this group, histories were obtained in twenty-two. In class 1 (onset 17 to 24 years), there were two negative statements; in class 2 (onset 27 to 39 years) there were four positive statements; in class 3 (onset 42 to 57 years) there were two positive and three negative; in class 4 (onset 59 to 70 years) there were three positive and two negative; and lastly in class 6 (epileptics) there were three positive. Of the twenty-two histories there were thirteen positive and nine negative, or 59 per cent. of heredity. It is worthy of note that the highest percentage occurs here in the epileptics and in the cases with an onset at middle life, although the small number of available cases discounts the value of the observation.

Group IV.—Of the thirty-seven cases in this group histories were available in fourteen. In class 1 (? recent seniles) there were no histories available; in class 2 (chronic seniles) there were five positive and three negative; and in class 3 (seniles with convulsions) there were three positive and three negative. Of the fourteen histories there were eight positive and six negative, or 57.1 per cent. of heredity.

Group V.—Of the twenty-seven cases in this group histories were obtained in eight. In class 1 (? recent seniles) there was one positive statement; and in class 2 (chronic seniles) there were three positive and four negative. Of the eight histories there were four positive and four negative, or a heredity of 50 per cent.

Of the total 200 cases, histories were available in eighty-four, and of these there was a hereditary history of insanity in forty-seven cases, or 56 per cent. This somewhat high percentage is very suggestive of the extreme importance of a hereditary predisposition to mental disease, and this is especially the case when the relatively unsatisfactory nature of the information made use of is taken into consideration.

As will be confirmed by the facts brought forward in the section on the etiology of dementia paralytica, where all the histories were personally taken by the writer, the material obtained from the relatives and friends of patients largely resolves itself into the following:—

- (1) Cases where definite psychopathy exists.
- (2) Cases where this cannot be obtained, but where the patient is the youngest (and the degenerate) of the family, or the youngest of a series of children, the remainder of the family following perhaps a gap of years; and where also there is frequently a history of alcoholic excess, or of phthisis, diabetes, &c., in the parents of families.
- (3) Cases where all or nearly all the relatives are dead, frequently from intemperance, phthisis, cancer, &c.

Class 3 and probably to a less extent Class 2, are evidence of a generally deficient vitality in the stock, or in the parents, rather than of a purely psychopathic taint, though naturally the latter is included in the former. It is the experience of the writer that careful and persistent search for additional information frequently causes facts to be elicited in cases which at first fall into Class 2 which place them in Class 1.

(4) Cases where no information or no trustworthy information can be obtained.

If the results obtained by different observers concerning the importance of a hereditary taint of insanity were classified under the above headings, it is probable that they would not show such extreme discrepancies as are found in them in their present form.

THE GENERAL PATHOLOGY OF MENTAL DISEASE (EXCLUDING DEMENTIA PARALYTICA).

From the evidence concerning the clinical symptoms and morbid changes found in the 200 cases of mental disease described in this part of the paper, it is clear that the latter vary in degree with the amount of dementia existing in the patient, and are otherwise independent of the duration of the insanity.

Amentia.—It is also evident that certain varieties of mental disease present no naked-eye abnormality of the intracranial fluid and membranes and are not prone to dementia. In these types it is common to find naked-eye under-

development, or asymmetry of the cerebral hemispheres, and particularly so in those cases where the family history discloses a psychopathic taint. This is probably explicable owing to the fact that the histories in the cases made use of were rarely personally taken, but are of the ordinary casebook type, for it may be taken for granted that in such histories only the more obvious and gross forms of heredity are recorded. As will be shown in the second part of this paper, in the varieties of mental disease under consideration (which include many types from idiocy upwards) there exists an underdevelopment of the pyramidal layer of nervecells which brings all such cases under the category of "amentia." This may be found to a very marked extent in cases in which the cerebral hemispheres are to the nakedeye little if anything below the normal limits. extreme example may be cited Case 9 (pp. 579-82), in which the general average measurements differ very little from those of Case 7, a stillborn female infant, although the hemispheres in the fresh unstripped condition weigh respectively 505 and 500 grammes, and are practically normal in appearance.

The milder varieties of amentia may remain "potential" lunatics till any period from childhood to the climacteric or later, the time of onset of symptoms which render them unsuitable to their external environment depending on the "stress" they are able to withstand. They then, on entry into an asylum, either remain there permanently; or, after one or several attacks, become permanent inmates; or they succeed in appearing, at any rate to the ordinary person, as normal individuals for the rest of their lives; or when senile vascular degeneration develops, they finally enter an asylum to die there.

Dementia.—On the other hand, cases with the mildest type of congenital deficiency, who are able to withstand much more "stress," when the breakdown occurs more frequently, if not usually, develop either a sufficient amount of mental enfeeblement to keep them in the asylum, unless their friends take them under their care, or a greater degree, which, however, is never more than moderate when un-

complicated by vascular disease. The cases in Group III. as a whole represent this class of patient, namely, the ordinary chronic lunatic with moderate dementia. In these cases a new factor is brought out by "stress," namely, deficient neuronic durability, and some degree of dementia ensues.

Many of these cases would probably never enter an asylum at all were it not for such special primarily toxic varieties of "stress" as alcohol and frequently child-birth, which induce in the highest degenerates a mental confusion from which they, however, frequently recover without obvious permanent after-effects (see page 548).

It is not improbable that in the same category may be placed many cases of adolescent and climacteric insanity in which the cortical neurones are, as far as can be made out, normally developed, and where the breakdown is associated with unusual and temporary general metabolic changes. The onset of insanity in such cases may not without reason be considered to be precipitated by an autointoxication of the cortical neurones.

As will be seen later, in many of these cases deficient neuronic durability is the primary essential factor in the break-down, the actual neuronic development being probably within the normal limits.

In other words, in the majority of cases of amentia deficient development exists alone, but in some of the highest grades deficient durability coexists. The latter condition may, however, exist alone in certain persons whose neuronic development is within normal limits.

Atheroma and dementia.—As has been shown in the section on atheroma, vascular degeneration appears to be unable, in any but a breaking-down cerebrum, to induce more than the mildest dementia, even when reacting on worn out neurones, as in certain chronic cases in Groups I. and II. (pages 480-1). On the other hand, when moderate dementia has developed, and the cortex is consequently in a condition of impaired vitality, vascular degeneration is a potent factor, probably by decreasing the nutrition and causing an auto-intoxication of the cortical neurones, in inducing the development of severe and finally of gross dementia, as in the cases contained in Groups IV. and V.

As a whole, as has been shown, it is remarkable how closely in the groups of cases the amount of naked-eye atheroma corresponds with the degree of dementia induced, but exceptions occur. One of these (No. 199 in Group V.), with apparently normal cerebral vessels, has been examined histologically as Case 19 in Part II., and considerable neuroglial, capillary and arterial proliferation was found to exist in association with the very severe cortical wasting and the gross dementia. A similar condition would probably be found to exist in the remaining small number of adult exceptions, though the chief factor in these rare cases is probably an extreme and early retrogression of the cortical neurones (see page 486, and also below).

It is now necessary to refer further to the primary essential factor in dementia, namely, deficient neuronic durability. As has been stated, there exists in most cases of mental disease a deficient neuronic development which may become evident at any age up to maturity. This is, however, actually associated with in many cases, and in the highest degenerates it is replaced by, a deficient durability of the cortical neurones and a consequent tendency to premature decay. This deficient neuronic durability, as will be seen in the section on dementia paralytica, is a very obvious feature of this variety of dementia, but, owing to the absence of the prolonged and insidious action of the syphilitic poison in the other types of dementia now under consideration, it is in these latter much less noticeable, except in the rare cases above referred to, unless vascular degeneration should supervene. Many cases occur amongst the ordinary adolescent types of insanity in which a relatively clever subject suffers from an acute attack of mental disease, and then rapidly passes into moderate dementia; and higher grade imbeciles when they become insane often rapidly pass into moderate dementia. These types resemble in many respects the second group of cases of juvenile dementia paralytica, which will be referred to later, and only differ from them owing to the absence of syphilitic infection, and consequent progressive reparative vascular and neuroglial proliferation, in becoming chronic moderate dements, instead of rapidly or slowly passing on to gross dementia in association with the usual para-syphilitic symptoms of dementia paralytica.

Summary.—Hence, neuronic insufficiency (as regards development, durability, or both) is the necessary antecedent of mental disease. Many cases are never sufficiently developed to pass as normal individuals, and many cases probably pass all their lives as normal individuals. In other cases, again, "stress" in the most general sense is the determining cause of the time of onset of an attack of insanity. The lower the degree of the neuronic development, the less is the "stress" which is required to precipitate the attack and the less is the damage which is done, and vice versâ.

The influence of "stress" in overcoming the durability of insufficient neurones, even of the highest types, is, however, limited, for the resulting damage, or in clinical terminology the ensuing dementia, is probably very rarely more than moderate in degree unless one of two additional factors supervenes (see page 479 et seq.).

Of these, the most common is the ordinary vascular degeneration, which frequently accompanies senility, and which rapidly causes the transformation of moderate into gross dementia. Vascular degeneration has, however, relatively little influence even on worn-out neurones, whether of deficient or normal development, so long as the limit of their durability has not by other means been reached, and some degree of dementia has not developed.

The other factor which is capable of developing gross out of moderate dementia, is the neuroglial and vascular reparative proliferation which may follow syphilitic infection, and which continues to increase, pari passu, with neuronic degeneration, till gross dementia and death ensue. This factor is also unable to act on normal neurones, but as will be seen in the section on dementia paralytica, it has more or less rapid, and eventually fatal, effects on neurones whose limit of durability, through the action of "stress," has been passed.

DEMENTIA PARALYTICA (GENERAL PARALYSIS OF THE INSANE).

The following section contains a summary of the views of the writer, derived from his clinical and pathological experience, on the etiology and pathology of this disease. He has endeavoured to demonstrate that dementia paralytica is not an organic disease of the brain but is a branch of ordinary mental disease, special clinical and pathological features being introduced in consequence of a former attack of syphilis; and that it develops solely in the actual or potential subjects of those types of mental disease which, owing to a hereditarily deficient durability of the cortical neurones, tend to end in dementia.

An account of the etiology of dementia paralytica is first introduced, and in this is included an etiological classification of the more common varieties of the disease. Certain types (normal and aberrent) of dementia paralytica are then detailed, this portion of the section being of the nature of a clinico-pathological description. An account of the morbid anatomy of dementia paralytica is then given and the section concludes with a paragraph on the general pathology of the disease.

Etiology of Dementia Paralytica (General Paralysis of the Insane).

The following account is based on a series of cases of dementia paralytica which have been under the writer's clinical observation during the past three years. The cases will be considered in two groups (1) private patients (males) admitted consecutively to Claybury Hall, nineteen in number, of which family histories have been obtained in thirteen, and (2) pauper patients in Claybury Asylum, eighty-three in number, of which satisfactory family histories have been obtained in seventy-two. The eighty-five histories which will be referred to are the outcome of several hundred interviews with any relatives or friends of the patients who were available, together with information obtained by other means.

Much labour has been expended on this subject, for the difficulties in the way of obtaining information concerning the family history of this class of patient are very great. Frequently the wife is the only visitor and the patient's family are unknown to her, and this is more often the case with patients suffering from dementia paralytica than in other forms of insanity, owing as a rule to the former loose life of the patient, which separated him from his friends. The age of the patient is again a serious drawback, as the older the patient the fewer are the relatives available who can speak trustworthily on the family history. Lastly, the frequency with which relatives are informed that the disease is not insanity, but is due to the former free life of the patient, really with the view to render them easy concerning the future of the off-spring, tends to make them hide many facts of family history which they would have otherwise mentioned.

To these eighty-five are added seventeen in which a personal history was obtained, or in which clinical or pathological study revealed etiological factors. In nearly the whole of the 102 cases systematic examination of the pupillary phenomena and the reflexes, &c., was carried out, and as a whole they constitute a fairly satisfactory basis for the study of the etiology of the disease. This is particularly the case as, owing to the fact that they do not consist of a consecutive series of admissions, the more chronic types of the disease relatively preponderate over the rapid ones. The writer cannot but think that erroneous views on the etiology of dementia paralytica may be readily formed when the majority of the cases used as a basis for study are of the ordinary textbook type. The juvenile, higher degenerate and tabetic varieties of the disease are equally important, and their relative frequency has not yet been satisfactorily determined. Many of these cases undoubtedly die at home or in workhouses undiagnosed, for only the cases which cause trouble are likely to be sent to asylums. "General paralysis without mental symptoms" may, perhaps, be referred to in this connection as probably the very highest grade of the postsyphilitic disease under consideration, although it does not

come into the sphere of alienism. The varieties of the disease could then probably, as will be suggested during this portion of the paper, conveniently be grouped as follows:—

- (I.) Dementia Paralytica.
 - (a) Juvenile dementia paralytica. (1) In imbeciles (usually chronic). (2) In high grade imbeciles who show mental symptoms about puberty (usually more acute).
 - (b) Ordinary chronic dementia paralytica in higher grade degenerates.
 - ¹(c) "Tabetic general paralysis," or dementia paralytica associated with extensive degeneration of lower neurones.
 - (d) Acute or subacute dementia paralytica in the highest grade degenerates (general paralysis of the text-books).
- (II.) General Paralysis without Mental Symptoms.

"Senile dementia paralytica" is necessarily excluded from this classification, as the cases according to type come usually under class (b). The morbid anatomy of these cases is, however, frequently that of gross dementia following vascular degeneration (p. 540).

It is suggested that in all the groups the syphilitic virus is a necessary factor; that in I. (a) (2) and I. (d) and possibly I. (c), "stress" in the widest sense is an important and necessary factor in determining both the time of onset and the actual course of the disease: that in I. (a) (1) stress is absent, and in I. (b) stress is less important, as the breaking-point is rapidly reached and the patient becomes relatively useless and stays at home or enters a workhouse, or, perhaps, finally an asylum; and that in II. stress, owing to absence of the hereditary taint which exists in I., is unable to determine the onset of dementia.

Of the 102 cases to be considered, Group I. consisting of the small series of private patients will be referred to in detail, whereas owing to considerations of space Group II., consisting of the pauper patients, in whom the details though perhaps in some cases less complete are equally satisfactory,

^{&#}x27;This type of the disease is introduced as above in preference to an artificial division of dementia paralytica into (a) dementia paralytica, and (b) dementia paralytica with involvement of lower neurones, for the cases are always mixed, although the affection of the lower neurones may be relatively slight. As, in cases when the latter is extreme, the patients are as a rule fairly high grade degenerates, the type has been introduced between (b) and (d).

will be summarised with reference to the different etiological factors.

Group I.—Of the nineteen male private patients summarised below, family histories were obtained in thirteen. In eight of these thirteen cases there was direct or collateral insanity; in three there were allied disorders, including epilepsy; in the twelfth the father died of cerebral hæmorrhage and the mother of paralysis, and the patient was the youngest of a family of eight; and in the thirteenth the mother and sister died of phthisis, a brother is delicate, and eleven out of the fourteen in the family are dead. Of the thirteen cases, in one instance the parents were first cousins, and a paternal uncle and two female cousins were insane; four patients were the youngest in the family; and in three families there was a very high death-rate. In four cases there was phthisis in the family (mothers and sisters), in two diabetes, and in one asthma. The history of alcohol was unsatisfactory, this being a point in which both patients and their friends make unreliable statements.

In all the nineteen cases more or less complete personal histories were obtained. In fifteen of these there was a history or evidence of syphilis, and the date of infection, where ascertained, was from four to twenty-five years before the onset of the mental symptoms. In Case 3, a tabetic, patient was twelve years in the army and was then in the police force, and had been married for twelve years without children; in Case 4, also a tabetic, patient was an Indian government official for over thirty years, and at the age of 37 married a half-breed, with whom he lived a jealous and unhappy life; in Case 8 patient acknowledged having had several gonorrheas, and orchitis of each testicle separately; and in Case 15 patient also owned to having had several gonorrheas and gleets, and also orchitis. Hence of the nineteen cases syphilis was certain in fifteen and highly probable in the remaining four.

Of the thirteen patients of whom complete histories had been obtained, ten were married. Three of the marriages were sterile (33 per cent.), and the other seven produced fourteen living and two dead children, and one stillborn fourteen years after the first child, which points to syphilitic infection after marriage. The age of marriage varied from 25 to 37 years (average 29.5). Comparison of this result with that from the pauper cases points to a much more satisfactory treatment of the syphilis contracted by the private patients. It is noteworthy that, in the private patients, the number of children per marriage is much below the average of $4\frac{1}{2}$ for England.

In the following cases only the very briefest ætiological details are introduced, for reasons of space.

Case 1.

Family history.—Brother died insane. Father is ruptured, and suffers from asthma. Patient is the youngest of a family of twelve.

Personal history.—Age 37. A Hebrew. Clerk, and on race-course. Moderate drinker. Syphilis. Married five years, three children. No miscarriages. Previous attack one year before admission without real recovery. Onset $3\frac{1}{2}$ years ago. Now going down hill. Has for a long time had a remarkably simian aspect and behaviour.

Case 2.

Family history.—Brother died insane.

Personal history.—Aged 53, traveller in whisky trade. Alcohol and syphilis. Married twenty-eight years, no children. Is dead. Disease lasted 1 + years, and was very acute.

Case 3.

Family history.—Father a soldier, who had several children who died in infancy. These were born before informant (eldest and female). Only one other sister alive. A sister died of phthisis at the age of 17. Father had softening of the brain for years, and used to see spirits. Half-brother, aged 28, is a high-grade imbecile who has never worked.

Personal history.—Aged 42, beerseller; in the army twelve years and then in police force. Married twelve years, no children. A case of tabetic general paralysis. Had tabes for 5 years and then died 15 months after the onset of dementia paralytica.

Case 4.

Family history.—Mother was insane and epileptic; five of seven in the family died young, and patient is the youngest.

Personal history.—Aged 54, Indian Government official for over thirty years. Married a young half-breed at the age of 37, and lived an unhappy and jealous life. Three children alive and two dead. An early case of tabetic general paralysis, with symptoms lasting 12 + years. Was discharged and afterwards relapsed.

Case 5.

Family history.—Maternal aunt insane.

Personal history.—Aged 48, solicitor. Syphilis. Alcohol, but not to excess. Married eighteen years; one girl alive aged 16 years, and fourteen years later a stillborn child. Died within two years of stated onset of disease.

Case 6.

Family history.—Mother's father insane, mother gout, father diabetes for twenty-three years.

Personal history.—Aged 31. Syphilis. Stockbroker. Married five years, two children. Died 4½ years after onset of disease.

Case 7.

Family history.—Uncle insane from sunstroke. Mother died of phthisis when patient, the only child, was seven years of age.

Personal history.—Aged 42, clerk. Syphilis, temperate. Married six years, no children. Died two years from stated onset of symptoms.

Case 8.

Family history.—Parents first cousins. Two female cousins, children of father's sister, insane. Father's brother is at present in an asylum, and has been there for twelve years.

Personal history.—Aged 35, stockbroker. Several gonorrhœas and orchitis in each testicle separately. Married for nine to ten years. No children. Wife left him, and he has lived with another woman. March 8, 1902.—Patient is now rapidly breaking up. December 24, 1902.—Patient is now in the last stage of his disease.

Case 9.

Family history.—Father suffered from hypochondriasis for years (from family doctor).

Personal history.—Aged 33, grocer. Syphilis ten to twelve years ago. Married six years, three children, no miscarriages. The case was a chronic one, but the patient died within two years of the stated onset of the disease, from tuberculosis of the

lungs, which was present and active on his admission to the asylum.

Case 10.

Family history.—Father epilepsy and melancholia, and from his voluminous correspondence is still at least highly neurotic. He was in the army for ten years. Maternal grandmother died of cancer, and mother of diseased ovaries at middle age. Patient is the fifth child of seven.

Personal history.—Aged 20. Patient was always a sensitive and nervous child, was clever, and won prizes at school till the age of fourteen years, when he fell off in his school work, and was afterwards unable to keep in a situation, and finally ran away from home. Died of juvenile general paralysis and subdural hæmorrhage. The skull showed marked signs of congenital syphilis. (For further details of this patient see Case 210, p. 527-8).

Case 11.

Family history.—All the family are very excitable and sensitive. Sister died of phthisis. Uncle died young of diabetes. Patient is the youngest of the family and was born after the death of his father.

Personal history.—Aged 35, on the Stock Exchange. Syphilis and alcohol. Married eight years, two children. Died 4½ years from stated onset of symptoms.

Case 12.

Family history.—No insanity, mother and sister phthisis, brother delicate. Eleven of fourteen in family dead.

Personal history.—Aged 44, sugar planter. Syphilis twelve years ago. Single. Symptoms 1 + year; was removed from the asylum by his friends.

Case 13.

Family history.—Probably no insanity. Father died of cerebral hemorrhage and mother of paralysis. Patient is the youngest of a family of eight.

Personal history.—Aged 35, architect. Moderate drinker. Syphilis eight years ago, doubtful second attack (apparent hard sore five weeks after connection) on admission. Single. Died two years from apparent onset.

Case 14.

Personal history.—Aged 53, publican. Syphilis twenty years ago. A chronic case who has occasional convulsions followed by much confusion. Is gradually failing.

Case 15.

Personal history.—Aged 47, no employment. Previous attack of insanity at the age of twenty-six. Several gonorrhœas and gleets, and also orchitis. Single. A chronic case who was removed from the asylum by his friends in a very feeble-minded condition.

Case 16.

Personal history.—Aged 51, artist. Took mercury for syphilis in 1875. Single. A chronic case. December 24, 1902.—All the symptoms have been rapidly progressing during the past few months.

Case 17.

Father suffered from syphilis and tabes.

Personal history.—Aged 37, doctor of medicine. Syphilis eighteen years ago. Single, but keeps a mistress, by whom he has had one living child. She suffers from some genital derangement, probably syphilis. Patient is a chronic case, with absent reflexes and dilated pupils, but no evidence of tabes. December 24, 1902.—Patient is now rapidly breaking up, and can hardly speak intelligibly.

Case 18.

Family history useless, but father died of cancer of the throat and mother of paralysis.

Personal history.—Aged 51, publican. Alcohol and syphilis. Married twenty-one years. Four children alive, none dead. Died within five years of stated onset of symptoms.

Case 19.

Personal history.—Aged 37, law student. Previous attack at the age of thirty. Syphilis four years ago. Married three years ago, and wife left him. Is in the early stage of dementia paralytica. December 24, 1902.—The dementia has progressed considerably during the past sixteen months, and there is much confusion of ideas. He has now marked delusions of electricity in his legs (? lightning pains).

Group II.—Summary of histories of eighty-three pauper patients suffering from dementia paralytica.—Satisfactory family histories were obtained in seventy-two and personal histories and clinical, and in some cases pathological, details in all the eighty-three cases.

Family history.—Of the seventy-two histories actual insanity existed in forty-five families (62.5 per cent.), and

in four of these true epilepsy also existed apart from insanity. True epilepsy existed in five other families without insanity (6.9 per cent.), though in one case it was probably associated with the melancholia of pregnancy. Histories of insanity and epilepsy consequently existed in fifty of the seventy-two families (69.4 per cent.). In these fifty families there were disorders allied to insanity in at least sixteen instances (nervous diseases not being included), this being of course part of the hereditary taint. In the forty-five histories containing actual insanity there existed sixty-five insane relatives. [These included ten brothers, ten sisters, eleven mothers, seven fathers, three maternal grandfathers, one maternal grandmother, two paternal grandfathers, one maternal great-grandfather, two maternal uncles, and five maternal aunts, four paternal uncles, and one paternal aunt, and eight collaterals (one half-sister, one half-brother, four cousins, one father's maternal cousin, and one sister's son). Several of these insane relatives suffered from fits, and a few may have been cases of general paralysis, but no stress can be laid on this, as the details are insufficient]. Of the twenty-two other cases in which complete histories were obtained, psychopathy (equals "borderland cases," and does not include nervous diseases) existed in nine (12.5 per cent.), two brothers, two sisters, three mothers, and three sons being affected; and of the remaining thirteen there was an abnormally high death-rate amongst relatives in no less than seven cases (9.7 per cent.); finally, of the remaining six, in three there was paralysis; in one the patient was the delicate child of the family, and did not walk until he was four years old; and in two there was merely a history of alcoholic excess of the parents.

Hence, of the seventy-two histories, there was psychopathic heredity in no less than 81.9 per cent., and an abnormally high family death-rate in another 9.7 per cent. In the remaining 8.4 per cent. less important etiological factors existed.

Further etiological factors obtained from family histories.

—Phthisis existed in nineteen of the seventy-two families (26.4 per cent.), in eight affecting brothers and sisters, and

in six the father's, in four the mother's, and in one both families.

Alcoholic excess existed in twenty-six of the seventy-two families (36.1 per cent.), both sides of the family suffering from the disorder in seven cases, the father's side in twelve, and the mother's in five; the remaining two cases occurred in sisters of the patients. General or nervous diseases were ascertained to have existed in nineteen cases (26.4 per cent.), and there was an abnormally high death-rate in thirteen (18 per cent.) families, it being so high in seven of these that very few family details could be obtained.

Personal factors: Syphilis.—This disease was proved to exist in no less than fifty-nine of the eighty-three cases in which personal details could be obtained. In some cases the information was obtained from the history, and in others from clinical evidence, or at the post-morten examination. Syphilis was also highly probable in eleven cases, there was no evidence for or against in eleven, and it was definitely stated by the relatives to be absent in two cases. Hence of the seventy-two cases of which use can be made it was certain or highly probable in seventy (97 per cent.), it was certain in 59 (82 per cent.), and in the remaining two the only evidence against was the definite negative of the friends, and the absence of clinical signs of the disease. In other cases where syphilis was proved to be present an equally definite denial was given by the friends. Of the fifty-nine cases in which it was certainly present, it was probably "congenital" in four, and was probably acquired after puberty in the remainder. Where the information was available the date of syphilisation varied from nine to twenty-five years before the onset of the dementia paralytica.

Families.—Of the eighty-three patients sixty-three were males and twenty were females. The average age of marriage of the males was 27 years, and of the females, 23 years. Of the sixty-three males eighteen were single and forty-six were Of the forty-six marriages seven were sterile (15 per cent.), and the other thirty-nine produced 182 (114 alive and sixty-eight dead) children and fifty + miscarriages or still-borns, giving an average for each fruitful marriage

of three alive, two — dead, and one + miscarriage. Of the twenty females five were single and fifteen were married. Of the fifteen marriages three were sterile, two had miscarriages only, and one had no children alive (40 per cent.). The remaining nine marriages produced sixty-five (thirty-five alive and thirty dead) children and fifteen + miscarriages, giving an average for each fruitful marriage of four - alive, three + dead, and two - miscarriages. The large families belonged to four patients over fifty years of age, except in one case, where the patient was married at the age of 17, and had six children alive, three dead, and three miscarriages. The remaining four produced amongst them only seven living, and eight dead children, and one + miscarriage. If these figures are at all trustworthy, sterile marriages are much more common in female patients than in male, which is probable also from the fact that the husband is more likely to be the first to suffer from syphilis. This paragraph should be compared with the corresponding one referring to private patients on pp. 509-510.

It may be added that alcohol in moderation or excess was taken by sixty-four of the eighty-three cases, and that nineteen of the patients were temperate. Little value can, however, be attached to these figures, as there is no means of judging of the accuracy of the statements made by the patient or his friends; and alcoholic excess may, perhaps, not unfairly be considered to be little, if anything, more common in dementia paralytica than it is in the ordinary lower class population of London. Whilst intemperance may contribute somewhat towards the development of the disease as part of the "stress" to which the patient is subjected, it cannot be considered to be an essential etiological factor.

Occupation.—Of the eighty-three patients, three were of no occupation, and the remaining eighty were stated to be of forty-nine different occupations. Of these there were seven seamen, three dock-workers, three fish-porters, two boatbuilders, four soldiers, four carmen, four painters, three tailors, two hotel-keepers, two printers, two railway officials, two washerwomen, and six housewives; and there were

thirty-six individual occupations, of which only five could be of any etiological significance whatever, namely, stockbroker, insurance agent, commercial traveller, policeman, and wine bottler. On the other hand, in the case of the private patients already referred to, at least one half of the occupations were likely to be associated with severe mental strain. It is hence probable that such factors as poverty, loss of work, drink, &c., may be of importance in determining the time of onset of dementia paralytica in the lower classes (a very large proportion of which cases are, in the experience of the writer, pronounced rather than highest grade degenerates), whilst business worry probably occupies a more important place as a factor in the "stress" which precedes the downfall of the middle-class patients (at least a large proportion of whom are degenerates of the highest grade).

Summary of Essential Factors.1

Heredity.—Actual insanity existed in forty-five of the seventy-two histories available, and true epilepsy existed in another five. Psychopathy or borderland cases of mental disease existed in another nine, and there was an abnormally high family death-rate in another seven. Of the six cases remaining, there was nervous disease in three, and in another the patient was the delicate child of the family, and did not walk till he was four years old. In the final two cases the only factor obtainable was a history of alcoholic excess in the parents. In the case of the thirteen histories of private patients, insanity existed in eight, psychopathy and epilepsy in three, and of the remaining two, in one case the mother and sister died of phthisis, the brother was delicate, and eleven of fourteen in the family were dead; and in the other the father died of cerebral hæmorrhage, the mother of

¹ The writer does not wish any comparison to be drawn between the percentages contained in this summary and the figures, drawn from case-book records, which have been published by a large number of writers. The former (see pages 501 and 506-7) have been prepared after most careful and persistent personal investigation, whilst the latter are necessarily very low and are thus useless for scientific purposes, for not only are the histories used usually taken, often in a perfunctory manner, from the first relative available, but frequently there is no statement that the figures are not made from the total admissions, without reference to the fact that in many cases no histories worthy of the name were taken at all.

paralysis, and the patient was the youngest of a family of eight.

Hence in the pauper class psychopathy was proved to exist in 59 of 72, or 82 per cent. of the cases, and in the private class in 11 of 13, or 85 per cent.

As these figures may seem unusually high, the writer wishes to again draw attention to the facts that he had several hundred interviews with relatives and friends in order to obtain the histories made use of, and that he endeavoured to obtain the most intimate knowledge possible of the family history in each case from every source available. Several of the histories were taken many times over, and in many cases the discrepancies between them were most extreme. A large number of the histories were not completed till eighteen months from the first interview, and not a single case was put on one side till it was quite certain that no further information could be obtained.

Personal:—Syphilis.—Of the eighty-three personal histories available syphilis existed in fifty-nine, and it was highly probable in eleven, making a total of seventy. In eleven no real evidence for or against could be obtained, and in two, in addition to this, it was strenuously denied. Of the nineteen personal histories of private patients, syphilis was present in fifteen, very probable in three, and at least probable in one. Hence, of the 72 cases available in the pauper class, syphilis was certain in 82 per cent., and probable in 15 per cent. of the cases; and in the private class it was certain in 79 per cent., and probable in the remaining 21 per cent.

Whilst the above two factors are, in the opinion of the writer, essential to the development of dementia paralytica, "general stress," which includes all varieties of overstrain, worry, and alcoholic excess, &c., in all probability plays an important part in determining the onset, or at any rate the time of onset, of the disease. The importance of this factor in any case varies largely according to the hereditary durability of the neurones, and to the activity of the syphilitic virus, and (see Cases 17 and 204) in types of insanity not prone to dementia even severe syphilitic infection is unable

to cause the development of dementia paralytica. In effect, dementia paralytica is a progressive dementia occurring in a syphilised 1 actual or potential lunatic possessing the type of hereditary insufficiency of the cortical neurones, which is prone to result in premature degeneration.

The comparatively rapid fatal issue in paralytic dementia is on a par with that seen in cases of gross senile dementia of the same type, and resulting from extensive vascular degeneration, which have already been fully referred to.

Clinico-pathological Types of Dementia Paralytica.

The following three cases are examples of dementia in syphilised subjects without the development of the special characteristics of dementia paralytica. In Cases 202 and 204 there is no heredity of insanity, and in Case 203 there is no family history. Case 202 appears to be an example of premature vascular senility and ordinary gross dementia in a patient who died at the age of 50, and had suffered from syphilis at the age of 42. Case 203 probably died of tuberculosis before the development of the disease, and this may especially be the case as the clinical record is unsatisfactory. Case 204 is that of a patient aged 79 years with gross vascular degeneration and post-mortem signs of syphilis. The patient was not grossly demented, and the case is a good example of the inability of syphilis to induce the development of dementia paralytica, except in a cerebrum containing neurones of decreased durability (cf. Case 17).

Case 202.

Admitted February 20, 1900. Died July 1, 1901. Male, Consanguinity. aged 50, married. Phthisis and alcohol on father's side. Mother died of paralysis.

History.—Syphilis seven years ago. Intemperate. Majority of children dead. Is confused and depressed. Hears his brother's voice. Has homicidal impulses.

¹ The question whether syphilis is ever really inherited is largely speculative. The signs of "inherited syphilis" in juvenile cases are probably the results of an attack of the disease which has been acquired during feetal life, or at or after birth. It is not unreasonable to suppose that, apart from actual infection, syphilis in the parents would act like other devitalising factors (phthisis, alcohol, &c.), and result in the production of offspring with the ordinary stigmata of degeneracy.

Course.—Scar on penis. Shotty glands in groins. Difficulty in passing his water. Is dazed, confused, depressed, suspicious, and rather cunning. Later improved, and was fairly rational in behaviour and speech, but was unstable and hypochondriacal. A year later was rapidly going down-hill physically and mentally, and died markedly demented.

Dura and S.D.—Natural. Great excess of fluid. Considerable recent blood-clot on both vertices. Pia.—No mid-line prefrontal adhesions. Slight fronto-parietal milkiness. Marked thickening. Strips like a glove, except at the extreme occipital pole. S.A.—Excess of fluid. Vents. L.—Considerably dilated. Somewhat granular. IV.—A few granulations in the lateral sacs, none elsewhere. Vessels.—Much thickened and very tortuous and calcareous throughout the brain, which shows considerable wasting, chiefly in the fronto-parietal region. Right hemisphere, unstripped, 550; left hemisphere, unstripped, 540; right hemisphere, stripped, 515; left hemisphere, stripped, 505.

Cause of death.—Broncho-pneumonia. There was gross degeneration of the median and small arteries throughout the body and brain, and extreme hypertrophy of the left ventricle. The large vessels were much thickened and dilated. The pupils were irregular and unequal. The bladder was hypertrophied. The testicles were very fibrous, and the liver and spleen fibrous.

Case 203.

Admitted March 13, 1895. Died April 3, 1900. Male, aged 43, single. No family history.

History.—Certified since March, 1893. Is dull and apathetic, and replies "No" to every question.

Course.—Is rambling and incoherent, and has delusions of persecution and following. Memory impaired. Takes no interest in his surroundings. Later became dull and lost, but not wet and dirty.

Dura and S.D.—Natural. Considerable excess of fluid. Pia.— No opacity. Considerable fronto-parietal thickening. Strips like a glove. S.A.—Excess of fluid. Vents. L.—Slightly dilated. A few granulations. IV.—Granulations in the lateral sacs. Vessels.—Natural. The brain shows considerable general wasting, which is most marked in the prefrontal region. Encephalon, 1,387; right hemisphere, unstripped, 580, stripped, 542; left hemisphere, unstripped, 580, stripped, 542; cerebellum and pons, 175.

Cause of death.—Tuberculosis. Lupus. Marked scar on the dorsum of the penis. Bladder hypertrophied. Testicles dense.

Case 204.

Admitted February 15, 1897. Died June 12, 1901. Female, aged 79, widow. Father died in a fit.

History.—Patient had eighteen children of whom twelve are dead. Is violent and has delusions of persecution by everyone.

Course.—Is confused, incoherent and childish, and has delusions of persecution. Is unoccupied but keeps herself tidy. Later was resistive, wilful and troublesome and unable to take care of herself. Continued till death to complain of persecution and ill usage, and was incoherent and very lost in manner.

Dura and S.D.—Adherent to the skull-cap in the frontal region. Slightly thickened. Excess of fluid. Pia.—Considerable frontoparietal opacity and thickening. Strips very readily. Mid-line prefrontal adhesions of pia to pia. No decortication. S.A.—Excess of fluid. Vents. L.—Slightly dilated. IV.—Granulations in the lateral sacs. Vessels.—Markedly atheromatous. The brain shows considerable general wasting. Right hemisphere, unstripped, 470; left hemisphere, unstripped, 455. Right hemisphere, stripped, 413; left hemisphere, stripped, 400. The immense amount of reparative proliferation, shown by the weight of the membranes in this case, should be noted (cf. Case 201).

Cause of death.—Pneumonia and cardiac failure. There are multiple serpiginous and pigmented syphilitic scars on the inner side of the left leg. The density of the liver and spleen is increased. The aorta is dilated and contains a little calcareous atheroma and a considerable amount of pearly-white fibrosis.

The next four cases form a series in which, though in the first two dementia paralytica was suspected, the disease was not definitely diagnosed ante-mortem. Case 205 is in reality an ordinary chronic case of the disease which did not suffer from convulsions, and which died of tuberculosis. It affords an excellent example of the degenerate type of the disease referred to on pp. 507-8 and 543, and is inserted for this reason. Cases 206-208 all suffered from convulsions described as epileptic. The first of these suffered from epileptic fits when a young woman, and had no more for thirty-one years. The pupillary changes suggested chronic iritis, and the diagnosis only became clear towards death. The post-mortem

signs were equally aberrent. Cases 207 and 208, on the other hand, both died from what appeared to be status epilepticus, and the post-morten signs were as unusual as was the whole course of the disease. In the case of No. 208 the diagnosis was only made certain by microscopic examination. This series of cases throws many sidelights on the nature of the disease. Case 205 is deserving of careful attention in relation to the paragraph on etiology, and the regions of the cortex affected in the others, especially the last two, prove in themselves, without further evidence, that the symptomatology of the disease varies with the part of the cerebrum affected. In cases of mental disease considered from the standpoint of simple amentia or of dementia or of dementia paralytica, the anterior part of the cerebrum is chiefly affected; but this, apart from amentia or dementia used in a general sense, is not universal, and the careful comparison of really complete and satisfactory mental histories, with post-mortem appearances not modified by decomposition, and studied in the light of the known functions of the cerebrum, should lead in the future to highly important results. In this connection may be mentioned the unusually severe acute affection of the lower association areas of the cerebrum in Case 20, in fig. 11, Plate III., of the second part of this paper (pp. 608-610).

Case 205.

Admitted October 26, 1898. Died August 2, 1901. Male, aged 35, married. Sister in an asylum for ten years. Wife insane. Phthisis and alcohol on father's side.

History.—Married thirteen years. No children. Steady. Market porter. At the age of 30 became dull, lost flesh and did no work. Is dull, stupid, incoherent, and cannot understand a question. Memory impaired. Repeats certain words over and over again.

Course.—Cannot give any account of himself. Repeats certain words and phrases—"A bottle of whisky and a bottle of rum," &c. Is very confused and his speech is thick and indistinct. Is restless and noisy at night. September 24, 1899.—Suspected of general paralysis. Pupils unequal. Facial and lingual tremors. April 2, 1901.—Demented and very lost. Curses and swears to himself in an inarticulate manner. July 10, 1901.—Advanced

phthisis. Pupils dilated and inactive. Knee-jerks absent. Plantars lively.

Dura and S.D.—Slightly thickened. Great excess of fluid. Pia.—Much fronto-parietal opacity and thickening. Adherent to the cortex. Congested. Considerable decortication on stripping. S.A.—Great excess of fluid. Vents. L.—Much dilated and granular. III.—Granular. IV.—Covered throughout with fine granulations. Vessels.—Apparently natural. The brain shows very marked prefrontal and marked general wasting. Right hemisphere, unstripped, 490; left hemisphere, unstripped, 500.

Cause of death.—Tuberculosis of the lungs, &c. Chronic general paralysis.

Signs of Syphilis.—The frenum is absent and there is marked phymosis. Shotty glands in the groins. Considerable first and second stage atheroma of the aorta and some pearly-white fibrosis. Spleen very dense and kidneys and liver dense.

Case 206.

Admitted July 16, 1900. Died August 3, 1901. Female, aged 50. Mother's uncle insane. Mother "could not drink." Father intemperate.

History.—Married thirty-two years, seven children alive and several dead; some of the later ones were still-borns and miscarriages. Patient, at the age of 19, was "out of her mind for three days when her first child was born." Began to have (chiefly) right-sided fits a year before admission. Previously had had no fits for thirty-one years. Became dull and stupid and was admitted shortly after a series of seven fits. Is confused, incoherent, wild, and excited. Mutters to herself and to imaginary people.

Course.—Very maniacal on admission and became collapsed from exhaustion. In November, 1900, was moderately demented. Did not know the day, or the date within a week. Clean and dresses herself. Slight tremor of the tongue. Speaks with a lisp. Left side of the face smaller than the right and apparent right facial paresis. Knee-jerks normal. Right pupil 3 mm., left pupil 4 mm. Accommodate to 2 mm. and 3 mm. Right reacts slightly and left doubtfully to light. Both irregular. The anterior layer of the central portion of the iris appears as if eroded off. Patient continued to be at times excited and restless but was usually despondent and dull, and of wet and dirty habits. She had occasional successions of convulsions.

Dura and S.D.—Skull-cap dense and dura adherent in the frontal region. Considerable excess of fluid. Pia.—Some fronto-

parietal opacity. Considerable thickening. Tends to adhere throughout to the cortex, but especially in the median portion below the falx, and many areas of decortication occur. There are a number of pial extravasations of blood. S.A.—Excess of fluid. Vents. L.—Somewhat dilated. A number of fine granulations. IV.—Lateral sacs markedly granular. Fine granulations elsewhere including the calamus. Vessels.—Both cortical and basal markedly atheromatous. The brain shows marked prefrontal and some general wasting. In the region of the right corpus striatum are a number of small superficial softenings lying under the ependyma. Encephalon, 1,145; right hemisphere, unstripped, 490; stripped, 460; left hemisphere, unstripped, 485; stripped, 455; cerebellum and pons, 155.

Cause of death.—General paralysis. Relatively little aortic atheroma. Spleen very, and kidneys somewhat, dense. Renal arteries natural. Left ventricle much hypertrophied. Some atheroma of aortic and mitral valves. Sessile cervical polypus in the uterus.

Case 207.

Admitted March 28, 1900. Died September 9, 1901. Male, aged 40, single. No family history (see below).

History.—Has had blows on the head. Has an imperfect idea of time, and does not realise his surroundings. Was found, without tools, taking up the pavement of a street in order to bury his coat in 15ft. of concrete.

Course.—Can give no account of himself. Confused and lost. Memory much impaired. Appears to have some hesitations in his speech. Says his maternal aunts and uncles have been in an asylum at Oxford. April 13, 1901.—Convulsion, described as typically epileptic. July 19, 1901.—Succession of ten fits. From September 3, 1901, to September 9, 1901, had a status of 186 fits, and died of exhaustion.

Dura and S.D.—Natural. Adherent to the pia in the right anterior and middle fossæ. Enormous excess of fluid. Over the right vertex and the whole of the base above the tentorium is a thin detachable brownish film covered with brown pin-points from punctate hæmorrhages. Pia.—Immensely thickened and opaque. Markedly adherent to the cortex in the prefrontal region, the right orbital surface, the right temporo-sphenoidal region, the inferior parietal lobules, and largely over the median surface. The pia is adherent to the dura in the right anterior and middle fossæ. S.A.—Considerable excess of fluid. Vents. L.—Very

dilated and granular. IV.—Granular throughout, especially in the calamus. Vessels.—Apparently natural. There are many superficial softenings in the right orbital surface and the right temporo-sphenoidal lobe. Right hemisphere, unstripped, 630; left hemisphere, unstripped, 630. Right hemisphere, stripped, 590; left hemisphere, stripped, 595.

Cause of death.—General paralysis. There is a marked scar on the penis. The aorta contains a few pearly patches. The right pupil is 7 mm. and the left is 4 mm.

Case 208.

Admitted June 25, 1896. Died June 30, 1900. Male, aged 42, married. Mother epileptic. Phthisis on maternal side. Alcohol on paternal side.

History.—Epileptic. Symptoms for four years. Strange in manner. Suspects other people of talking to loose women. Says he writes such matters down as they are important. Talks to himself. On one occasion acted indecently.

Course.—Palate high. Sight in the left eye deficient. Right knee-jerks much exaggerated. Somewhat incoherent. Memory much impaired. Vacant and listless at times. Each month has about ten fits, some of which leave him lost and confused. November 18, 1898.—Is occasionally dazed, lost, untidy and defective in his habits. Cannot take care of himself for some days after a fit. Died of cardiac failure after a few severe fits thirty-six hours previously.

Dura and S.D.—Natural. Slight excess of fluid. Pia.—No opacity. Considerable thickening. Strips fairly readily over the fronto-parietal region, but is exceedingly adherent to the cortex on the whole inner surface of the brain. Here, and to some extent on the posterior part of the brain and the superior parietal lobules, considerable decortication takes place. There are extremely marked mid-line prefrontal adhesions. S.A.—No excess of fluid. Vents. L.—Very slightly dilated. IV.—Granulations in the lateral sacs. Vessels.—Apparently natural. Encephalon, 1,302; right hemisphere, unstripped, 555; left hemisphere, unstripped, 545; pons and cerebellum, 155. Microscopic examination proved the case to be one of dementia paralytica. The bladder was hypertrophied and the liver, spleen and kidneys were dense.

The following seven cases are examples of the types of dementia paralytica referred to in the classification on page 508. Cases 209 to 210 are instances of the juvenile form of the disease, the former being an imbecile and the latter a patient who broke down mentally about puberty. Case 211 is one of tabetic general paralysis; Cases 212 and 213 are male and female chronic patients without reflexes; and cases 214 and 215 are male and female very acute cases with increased reflexes and alternating pupils. These more ordinary types of the disease may be usefully compared with the rarer cases previously cited.

Two Cases of Juvenile Dementia Paralytica.

Case 209.

Admitted November 20, 1899. Male, aged 21.

History.—Alcohol on paternal side. A child of father's brother is in an imbecile asylum. Another died an idiot at the age of 4 years. Father a tailor. Denies syphilis. Mother before marriage a tailoress. They went to school together. Their children are: female aged 29, male aged 27, male aged 25, female aged 23; all healthy. Patient is the next child. There were no children or miscarriages for nine years and the parents lived together; then a male aged 12 years, healthy, and then a female aged 9 years who is weak and delicate, has a high forehead, irregular teeth and a narrow palate, and is stated to be "clever" for her age.

Personal history.—Mother fell down stairs when six months pregnant with patient. He was tongue tied till 6 years of age and he gradually improved in speaking after it was cut. He walked very late and very soon showed that he was different from other children. Fits from 4 years of age, went to school for five or six years, left about 15 in the second standard. "Could learn to read but nothing else; 'twas no good sending him to school." Before being sent away he was "rather rough at home and ill-used by boys in the street." In a few months was sent to an imbecile asylum and was there for four years. Even at this time "it was as much as he could do to hold a knife and fork." November 21, 1900.—Knows day and date but is of very low intelligence and unable to work. Can only give the poorest account of himself. Short, broad nose, slight beard on upper lip, chin and cheeks. Speech tremulous, slurred and hesitant. Decreased facial expression, and marked tremor of lower face when speaking. Teeth irregular, badly enamelled and peg-shaped. Tongue very tremulous and jerky. Head large, with a depressed frontal suture. Grips equal but tremulous. Knee-jerks + +, patellar jerk, soleus jerk; all superficial reflexes exaggerated; right cremasteric greater than

left; testicles small, especially the left; penis shows signs of masturbation; glands in groins, especially the left. Elbow and wrist-jerks present, muscular sense and sensation normal. Legs rigid when walking. Hypotonus to a right angle with the trunk. Pupils in faint light, right $4\frac{1}{2}$, left 5. Accommodate to right 3-, left 3, and with strain to right 2½, left 2½+. No reaction to light but with strain and a bright light close to the face, right 2-, left Right irregular, left slightly irregular. Vision, right §, left §. Early gray atrophy of the right disc. October 31, 1901.—The general tremor and the signs of juvenile dementia paralytica are more marked. February 26, 1902.—Until recently patient has acted as a golf-caddie. He was quite useless excepting for the carrying of clubs, but eventually had to give up owing to a rapid increase of his physical symptoms. He became unable to walk the round owing to fatigue. December 24, 1902.—The symptoms are progressing. Patient had his first convulsion on July 7, and he has had others on August 19, September 19, October 27 and 30, and December 1.

Syphilis.—The physical signs strongly suggest 'congenital' syphilis, but the history is negative. The case has, therefore, been included in the list of 'probable' cases. (In this connection see page 486.)

Case 210.

Admitted November 1, 1900. Died March 29, 1901. Male, aged 21, single. (See also page 512.)

History.—Father epileptic, and when fits were numerous suffered from mild melancholia; in army thirty years ago for ten years. Patient at the age of 4½ years was very depressed for six months, owing to the death of his mother. Was very clever at school and nearly always was first or second in his classes. At the age of 14 years he became backward, was taken from school, and was tried in several situations which he was unable to keep. In November, 1896, he was dismissed from the last and ran away from home. Two years later he was found 60 miles from Buenos Ayres in a ranch with an uneducated companion, and he was obviously insane. A year later he attempted suicide, was put in an asylum, and was then brought to England in the hope that he might recover.

Physical.—Stoops and carries his head like a hunchback. Superficial scar on neck. Dull and vacuous expression. Slow speech which is deliberate and at times slurred. Tongue tremulous. Right pupil at times larger than left. Knee-jerks

increased. Other reflexes normal. Recent circumcision scar on penis (to correct masturbation.)

Mental.—He gives a very complete account of his past life, but shows a considerable amount of mental hebetude. He makes his statements in a perfectly unconcerned manner, like a child repeating a lesson. He suffers from auditory hallucinations preceded by sounds in his ears. November 19, 1900.—Attacked another patient with a table knife. December 12, 1900.—More depressed, threatens suicide, says he often speaks without knowing what he is saying. February 20, 1901.—Made a sudden and nearly successful attempt at suicide with a table knife. February 22, 1901.—Doing well. Says he attempted suicide owing to headache and sleeplessness, of which he has at times complained since admission. March 14, 1901.—Constantly complains of headache, not definitely localised; and also of generalised pains in the limbs and body, which are most marked in the arms. The pains especially in the head are worse at night. No changes in the retine or discs. March 29, 1901.—This morning patient made the same complaints and was in his usual condition. Nothing abnormal noticed. At about 10.30 a.m. whilst walking in the airing court, he suddenly fell down and appeared to die at once.

Post mortem.—Sutures of skull very prominent, especially Marked chronic osteitis and numerous internal internally. bosses. Bone very hard. Dura and S.D.—Natural. Some excess of fluid, and above the tentorium about \(\frac{1}{2} \) oz. of clotted blood and a similar amount of fluid blood. There is a rupture of the pial vein passing from the left great anastomatic vein to the lateral sinus near the latter. The blood lies in and near the left posterior pole of the cerebrum. The neighbouring part of the brain is intensely congested, and both hemispheres show signs of compression, which agrees with the fact that the dura before opening appeared to be tightly stretched over the underlying parts. Pia.—No opacity. Some thickening. prefrontal adhesions. The pia here is granular and adherent to the cortex. S.A.—Some excess. Vents. L.—Granular, especially on the roof and inner wall. III.—Granular. IV.— Covered everywhere with fine granulations. Vessels.—Apparently healthy. The brain shows relatively little wasting. The total weight is 1,535 grammes.

Cause of death.—Subdural hæmorrhage, with sudden cardiac and respiratory failure. Juvenile dementia paralytica. Chronic osteitis of the skull-cap, undoubtedly syphilitic in nature.

Tabetic General Paralysis.

Case 211.

Admitted February 1, 1900. Died October 30, 1900. Male, aged 50, single. Cousin in an imbecile asylum for more than thirty years. Maternal grandfather intemperate.

History.—Stockbrokers' accountant. He suffered from syphilis twenty-five to thirty years ago, and has during this period been much overworked. During the past two years, and perhaps for three or four (according to his brother), his walking has been bad. "The pupils of his eyes were like pin-points, and he raised his feet high from the ground." He has been abstemious for many years. In December, 1899, he was very jovial and artificial in his manner, and shortly after began to ramble in his conversation. Slept badly, and had delusions of suspicion and persecution. Was then certified; and was excited, heard voices about a conspiracy, and thought that his brother had stolen his money.

Course.—Pupils irregular, contracted and fixed. Romberg's sign present. Gait tabetic. Knee-jerks absent. Dazed, lost, confused, depressed, restless, short-tempered, impulsive, and violent. Auditory hallucinations. Sleep bad. Habits clean. Statements contradictory and rather rambling. Says he has had shooting pains in his legs for years. May 30, 1900.—Is now wet. Knee-jerks absent. Pupils equal 2 mm., irregular. Accommodate rapidly to 1 mm. No reaction to light. August 1, 1900.—Constantly wet. Very shaky on legs. Cannot walk alone. Right pupil, 2 mm.; left pupil, 12 mm. Accommodate to 12 mm. and 11 mm. respectively. Both irregular. August 23, 1900. -Failing very rapidly, very wet and dirty, stamps with heels when walking, and throws his legs about; can only walk with assistance. Tongue very tremulous, speech rapid and slurred and without R's. Knee-jerks absent, hypotonus to 20° beyond Right pupil, 12 mm.; left pupil, 12 mm. the vertical. Both accommodate rapidly to 1 mm. and 1-mm. Both irregular. Patient gradually sank, and died of broncho-pneumonia with acute pyelitis and cystitis. He had no convulsions during his illness.

Post mortem.—Scar on glans penis, shotty glands in groins, liver spleen and kidneys dense. Large amount of first and second stage atheroma throughout aorta and numerous pearly-white fibrotic patches. Dura and S.D.—Natural. Slight excess of fluid. Thin brown film above the tentorium most marked on the left side and in the anterior and middle fossæ.

Pia.—Apparently natural. Slightly thickened. Strips rather more readily than natural. No mid-line prefrontal adhesions, but considerable granularity of the pia in this situation. The pia is also adherent to the subjacent and congested cortex. S.A.—No excess. Vents. L.—Slightly dilated. A few slight granulations. IV.—Granular throughout. Vessels.—Apparently natural. The brain is ædematous, and shows slight prefrontal wasting. Weight, 1,395; cerebellum, 175. Right hemisphere, unstripped, 600; left hemisphere, unstripped, 605.

Cause of death.—Broncho-pneumonia. Acute pyelitis and cystitis. Tabetic general paralysis.

The relatively slight degree of cerebral wasting is probably associated with the very rapid progress of the dementia (see p. 537).

Two Cases of Chronic Dementia Paralytica (Knee-jerks absent).

Case 212.

Admitted February 11, 1899. Died February 22, 1901. Male, aged 40, married. Hotel-keeper. Paternal aunt insane, father eccentric.

History.—Two children alive, one dead. Symptoms four years. His habits changed, and he neglected his business and slept badly. Certified January 4, 1899.—Progressively weaker in mind for months, cannot keep his accounts, frequently spending his money aimlessly. Wanders about the house at night, set fire to his pipe and clothes, has had three convulsive attacks, and has sometimes lately been wet in his habits. During the year previous to admission has had unequal pupils, difficulty of articulation, tremor of tongue and upper lip, great hesitation of speech, slight unsteadiness of gait, and exalted ideas of health and strength.

Course.—Pupils fixed, left knee-jerk absent. Thinks he is Jesus Christ, and that he has no end of money, six wives and twenty children. Restless at night, and destructive. His symptoms gradually progressed. July 24, 1900.—Tremor so marked that he is hardly able to speak at all. Knee-jerks absent. Right pupil 4 mm., left pupil 3 mm., accommodating to 2½ mm. and 2 mm. No reaction to light. Dementia well marked. October 25, 1900.—Right leg can be raised to within 20° of the vertical, and left to within 15°. Is obedient, but very lost and shaky, hardly able to stand or walk, and wet in his habits. January 1, 1901.—Knee-jerks absent, hypotonus to 15° beyond the vertical. Right pupil 3 + mm., left 3 mm., accommodate to 2 mm. and

2-mm., both irregular. Has lost flesh, is wet and dirty in his habits, and is rapidly going grey. Has had numerous convulsions, chiefly left-sided, and at the present time has left facial paresis. He is exceedingly shaky and tremulous.

Post mortem.—Shotty glands in groin, especially the left, no visible scar on penis, old pigmented scar on the middle of the right leg. Dura and S.D.—Congested. Enormous excess of fluid. On the right vault and to a less extent to the left is a recent film of clotted blood, which is readily stripped off. At the base the dura is congested, and there are a few pieces of recent reddish film in both anterior and in the right middle fossæ. Pia.—The vault of the right hemisphere is covered with subarachnoid extravasations, and there are a few on the left. The fronto-parietal region is very opaque and thickened, and intensely congested; there are marked mid-line prefrontal adhesions below the falx cerebri, and considerable decortication takes place. S.A.—Considerable excess of fluid. Vents. L.—Much dilated, covered with small granulations, choroid very congested. IV.—Covered with small granulations. Vessels.—Apparently natural. Weight of encephalon, 1,205 grammes. The left hemisphere is extremely soft and watery in its anterior half.

Cause of death.—Exhaustion of dementia paralytica.

In this and the following three cases further details concerning the cerebral hemispheres will be given later (pp. 536-7).

Case 213.

Admitted February 1, 1900. Died August 11, 1900. Female, aged 32 years, washerwoman. Paternal grandmother died of paralysis. Mother practically a dement, who makes the most untrustworthy statements.

History.—Difficult to obtain, owing to the exceedingly bad memory of the mother, who is aged 58, is a washerwoman, and ought to be in an asylum herself. Patient is the second child of a large family, mother has no idea how many there are in the family, and cannot even approximately state how many are alive, she does not even know the month of the year. About two years ago patient had a fit, and lost her speech for some hours; for months she has complained of pain in her right hand and arm, and had frequently to stop washing to rest it. Her conduct has been different, and she has constantly talked nonsense. Some weeks ago she had another fit, and was unconscious for one and a half days; during this time she could not speak. Three days

before admission to the workhouse she had a fit, was unconscious, and did not speak during the three days. According to mother patient has been a steady, sober, and hard-working girl, and has never gone for a walk with a man in her life (see autopsy). Was taken to the infirmary on a stretcher in a filthy condition with a discharge from the vagina; was taciturn, indifferent to her surroundings, and unable to comprehend questions.

Course.—Excited, talkative, and restless, and always asking for beer. Talks to herself, and says she was married last week. Has exalted ideas about her belongings and possessions, is wet and dirty in her habits, left pupil larger than right, hardly any reaction. Knee-jerks absent. April 20, 1900.—Epileptiform attack, temperature 105° . July 5, 1900.—Recovering from a succession of severe convulsions. Knee-jerks absent. Right pupil $4\frac{1}{2}$, left 5 mm. Accommodate to 3 and 4, no reaction to light. July 19, 1900.—Is practically inanimate, but seems as if about to cry when interfered with. Has several bed-sores.

Post mortem.—Cystitis. Cervix chronically inflamed. Outer parts of fallopian tubes thickened and varicose. Body of uterus subacutely inflamed at orifice of right fallopian tube. Kidneys dense, and liver and spleen somewhat dense. The only atheroma is a trace in the upper part of the abdominal aorta. Dura and S.D.—Natural. Large excess of fluid. Pia.—Marked frontoparietal opacity. Intensely congested and much thickened. Marked mid-line prefrontal adhesions below the falx, and pia is adherent to the cortex, which tears on stripping. S.A.—Large excess of fluid. Vents. L.—Considerably dilated and granular. IV.—Covered throughout with minute granulations, which are most marked in the calamus. Vessels.—Natural. Weight of encephalon, 985 grammes. Weight of hemispheres, 830 grammes.

Cause of death.—Exhaustion of dementia paralytica.

It is worthy of note that both this case and the preceding had shown symptoms for a long time before admission.

Two Cases of Rapid General Paralysis (Increased Reflexes and Alternating Pupils).

Case 214.

Admitted August 2, 1899. Died January 19, 1901. Male, aged 40, single. Coachman. No heredity of insanity. Mother drank heavily and died young.

History.—For the last twenty years patient has been very

religious, and has also taken an interest in athletics. He has probably had little or nothing to do with women. Has been very steady, and began to drink heavily three months before admission. Was very violent, and in gaol three to four times during this period. He also spent his money freely. When certified, he said that he went to Klondyke in 1832, and made from four to five millions of money. Also said that he had thirty-three brothers and sisters, all alive. Frequently asked for a knife to kill himself, and said that he would kill his friends.

Course.—Right pupil slightly larger than left. React sluggishly. Knee-jerks normal. Speech slurred. Facial tremors. Says he can swim twenty miles in two hours. Is depressed and despondent, and says that he will kill himself with a knife. March 20, 1900.—Does a little work. Is emotional and demented, and has grandiose delusions. Right knee-jerks + +, patellar clonus. Left knee-jerks + +. Pupils equal 2½ mm. Accommodate to 2 and 12 mm. respectively. No reaction to light. July 18, 1900.—Has numerous delusions of wealth and strength. Is lost to time and place, and wet. Very violent and under sulphonal. Speech slurred and explosive. Tremor of tongue and lips. Kneejerks equal and + +. Right pupil 2 mm., left pupil 2 mm. Accommodate to $1\frac{2}{3}$ and 2 mm. Fixed to light. August 23, 1900.—Left hæmatoma auris. October 2, 1900.—Very exalted. Speech indistinct and slurred. Marked tremor. Can only with difficulty be got to put out tongue. Knee-jerks equal + + +, patellar clonus. Right pupil 23 mm., left 23 mm. Accommodate to $1\frac{2}{3}$ and $1\frac{1}{3}$ mm. Fixed to light. Hypotonus to a right angle with the trunk. Patient rapidly became worse, being quite lost and very shaky, and died of lobar pneumonia. An alternating condition of the size of the pupils existed in this case. The patient did not suffer from convulsions.

Post mortem.—No post-mortem signs of syphilis. Spleen very dense. Dura and S.D.—Natural. Excess of clear colourless fluid. On the right vertex, in both anterior fossæ, and in the right middle fossa is a detachable brownish film. Pia.—Somewhat adherent to the dura in the right middle fossa, and in both anterior fossæ, especially the left. Relatively little fronto-parietal opacity and thickening. Mid-line prefrontal adhesions and decortication. S.A.—Excess of fluid which in the prefrontal region balloons out the membrane. Vents. L.—Very dilated, especially the right. IV.—Granular. Vessels.—Natural. Weight of encephalon, 1,225 grammes.

Cause of death.—Lobar pneumonia and general paralysis.

Case 215.

Admitted December 8, 1898. Died January 6, 1901. Female, aged 36. Mother insane. Mother's sister had fits, and was paralysed. Mother's family curious and drunkards.

History.—Always very eccentric. Lived with a man for fifteen or sixteen years. Left him three to four years ago, and lived with her brother-in-law's family. Three months ago she suddenly left. The family only heard where she was through the newspaper. When certified her speech was stuttering, her lips were tremulous, and her gait was unsteady. Confused. Said she had been in Holloway prison. Grandiose. Said she made wreaths for the Queen and the Prince of Wales.

Course.—Memory is defective. Says she is married to the gipsy king, and that she has twins, one aged 19, and the other 28. Is rambling and incoherent, and had aural hallucinations. Later became brighter and cheerful and did some work in the ward. March 8, 1900.—Well-marked dementia. Feeble. Gait very spastic. Knee-jerks + +, patellar clonus. Right pupil $2\frac{1}{2}$ mm., left 2 mm. Accommodate to $1\frac{1}{3}$ mm. and 1 mm. No reaction to light. April 6, 1900.—Unable to stand or walk alone. July 19, 1900.—Destructive, wet and dirty, and demented. Legs very rigid. Knee-jerks + + +, patellar clonus. Right pupil 2\frac{2}{3} mm., left 2\frac{1}{3} mm. Accommodate to 2 mm. and 2 - mm. No reaction to light. October 11, 1900.—Looks happy, but is very thin and constantly grinds her teeth. Left facial paralysis. Says with an indistinct drawl that she is all right. Right pupil 2 mm., left 2 mm. Accommodate to 1 mm. and 1 mm. November 20, 1900.—Lies crouched up in a chair. Voice an unintelligible drawl. Face quite expressionless. Pupils are now irregular. This case also shows alternating pupils. She had several successions of convulsions during the latter part of her illness.

Post mortem.—Bladder hypertrophied. Both fallopian tubes dilated and bound down by adhesions; ovaries can barely be recognised. Liver spleen and kidneys dense. Dura and S.D.—Natural. Large excess of clear fluid. On the under surface of the dura, and also the external surface of the pia, are a number of small blood extravasations which arise from the very congested pial veins. Over the Rolandic area in the left hemisphere and to a less extent in the right are extensive sub-arachnoid extravasations of blood, and the surface of the arachnoid is granular, slightly sticky, and somewhat adherent to the dura. On these adherent surfaces are small punctate extravasations. Pia.—

Relatively little fronto-parietal opacity and thickening. Mid-line prefrontal adhesions below the falx, and decortication on stripping. S.A.—Relatively little excess of fluid. Vents. L.—Considerably dilated and granular. IV.—Very granular. Vessels.—Apparently natural. The whole brain is much congested. Total weight is only 782 grammes.

Cause of death.—Exhaustion of dementia paralytica.

This patient and the preceding, contrary to what occurred in the case of the two chronics, only showed symptoms for three months or less before their admission.

Summary of Cases 209 to 215.—These examples of dementia paralytica, none of which have been previously published, are introduced in a condensed form, partly as fairly typical illustrations of the disease, and partly as examples of the material made use of by the writer for the section on etiology. No. 209 is still alive, but the case is such an excellent example of the low-grade juvenile variety of the disease that, in spite of the absence of a post-mortem examination, the writer felt called upon to choose it out of the material at his disposal. No. 210 died at an early stage of the disease, but excellently illustrates the high-grade juvenile type. No. 211 is in every respect a typical case of the tabetic form of the disease. Nos. 212 and 213 are fairly average chronic cases without knee-jerks. Both cases had shown symptoms for a long period before admission. The former was admitted in an advanced stage of the disease, and shows both the usual heredity of insanity and very typical physical and mental symptoms. The latter was in type a chronic case, but was admitted in a most feeble and neglected condition, and died of exhaustion. The mental condition of the mother, a "borderland" case, is worthy of Nos. 214 and 215 are the most typical examples seen for some time by the writer of the spastic rapid variety of the disease, and it is an interesting fact that both possessed very small alternating pupils. In the former both heredity and syphilis were strenuously denied, and, though these negatives were used for statistical purposes, they are not necessarily accurate. The latter had a marked heredity of insanity, and had probably suffered from syphilis, as she

showed signs of other venereal disease, and had lived a very immoral life. Both these cases were admitted about three months after the first signs of the disease became evident.

The morbid anatomy of the last four cases will now be considered from a comparative point of view. The encephala of the females (Nos. 213 and 215) weighed respectively 985 and 782 grammes (average normal, 1,275 grammes), and both in their remarkably low weights and the simplicity of their convolutions were markedly the brains of degenerates. Those of the males (Nos. 212 and 214) were much below the average normal, weighing 1,205 and 1,225 grammes respectively (average normal, 1,400 grammes), but they differed from the female brains in being convoluted in a fairly average manner. The condition of the pia-arachnoid and the degree and site of cerebral wasting were as follows¹:—

Rapid spastic cases. Nos. 214 and 215.—In both cases there existed relatively little opacity and thickening of the pia-arachnoid, this occupying the fronto-parietal region, and there was only a moderate amount of wasting, which was chiefly visible in the prefrontal region.

More chronic cases without knee-jerks. No. 212. Male.—There is considerable fronto-parietal opacity and generally marked thickening of the pia-arachnoid except at the occipital pole and on the under and inner part of the temporo-sphenoidal region and the orbital surface of the frontal lobe. In the region of the marked thickening, the pia strips like a glove from the brain. The wasting is extreme in the prefrontal region, marked in the first temporal gyrus and the inferior and superior parietal lobules, rather less marked in Broca's gyrus and the posterior thirds of the first and second frontal gyri, moderate in the ascending frontal gyrus, slight only in the outer part of the temporo-sphenoidal and preoccipital regions, and almost absent in the occipital lobe, the lower and inner part of the temporo-sphenoidal region and the orbital surface of the frontal lobe.

^{&#}x27;See figs. 11, 16 and 17, Plates III. and V., in conjunction with this description. Different cases have been used for illustrative purposes in order that a larger number of examples may be given.

No. 213. Female.—The pia-arachnoid shows considerable opacity and marked thickening, which is most obvious in the frontal lobe, the first temporal gyrus, and the superior and inferior parietal lobules. The wasting is extreme in the prefrontal region, marked in the first temporal gyrus and the superior and inferior parietal lobules, moderate in Broca's gyrus and the posterior third of the first and second frontal gyri, much less in the ascending frontal gyrus, and slight or absent elsewhere.

(Note.—The terms used above for the cortical regions overlap somewhat, but are convenient for brevity of description.)

These morbid appearances agree closely with the clinical course of the disease in the several cases. In the two which rapidly broke down, the total amount of intracranial fluid, the morbid state of the pia-arachnoid and the amount of cerebral wasting, were all much less than in the two cases of chronic type, and it is not unreasonable to consider that this was due to a less complete removal of the products of degeneration and a lesser degree of finality, as regards cell-death, in the degenerative process.

Morbid Anatomy of Dementia Paralytica.

Only certain details in which the morbid anatomy of dementia paralytica differs somewhat from that of ordinary dementia will, for reasons of space, be referred to in this section.

As a rule, as also occurs in *status epilepticus*, the venules, &c., of the intracranial membranes and encephalon are intensely congested, probably in association with the epileptiform convulsions, which so frequently occur prior to death.

Even in relatively early cases of the disease, the excess of subdural fluid is large, and in advanced cases it is as great or greater than occurs in ordinary gross dementia.

In male patients, though probably not in female, owing to their usually greater chronicity, subdural deposits are somewhat more common than in ordinary severe dementia.

This is probably associated with the more marked abnormality of the cerebro-spinal fluid in dementia paralytica, combined with the more acute and extensive degenerative processes; and it is predisposed to by the frequency with which epileptiform convulsions occur during the course of the disease.

In early cases there is little or no excess of subarachnoid fluid; in slow chronic cases there is often considerable excess, frequently in the form of scattered "arachnoid cysts"; and in advanced cases there is great excess, the prefrontal pia-arachnoid being in many instances ballooned out by the subjacent fluid.

In early cases the pia-arachnoid may superficially show little abnormality beyond a larger or smaller amount of congestion; in later cases it is, as a rule, immensely thickened and opaque, and stretches as a continuous sheet over the subjacent sulci. The thickening and opacity are, usually, most marked over the fronto-parietal and first temporal regions and the neighbouring median part of the hemispheres, excluding, as a rule, the prefrontal region where the membrane is pushed up by subjacent fluid. The opacity may, however, be more widespread, and may even occupy the whole cerebrum excepting, apart from rare cases, the orbital surface of the frontal lobe, the lower and inner occipito-temporal region, and the posterior pole of the hemisphere.

Even in early cases of the disease the pia-arachnoid is granular in the mid-line prefrontal region below the falx cerebri, and pia adheres more or less firmly to pia in this position, the actual area depending on the size and shape of the falx cerebri. In later cases adhesions in this region are marked. It is worthy of note in this connection that the region under consideration is the only one in which pia meets pia, as elsewhere the pia lies in contact with the dura, to which however it only very rarely forms adhesions.

Particularly in early cases, and also in later ones in the regions into which the disease is spreading, the pia is adherent to the subjacent cortex. Later on when the pia-arachnoid has become much thickened and the wasting is pronounced, the membrane strips like a glove from the

underlying cortex. Decortication on stripping is usually laid much stress on in descriptions of the disease, but it is an uncertain sign. The more chronic, or the more advanced, the case happens to be, the less is the decortication, and vice versâ. Decortication, on the other hand, is much increased by cedema of the brain, and especially by postmortem changes. It is largely obviated by the absence of these latter factors, but in early cases it very frequently occurs in the mid-line prefrontal region below the falx cere-The peculiarly localised areas of adhesion, which are usually situated on the flat external surface of the convolutions, and do not reach to the fissure-lips, and the occasional occurrence of abnormal appearances, examples of which have already been cited (Cases 206 to 208) point almost conclusively, in the opinion of the writer, to a vascular origin. This is practically proved by the exactly similar regions of decortication which occasionally occur in gross senile vascular degeneration, an example of which is cited in Case 201, and illustrated on Plates III. and IV., figs. 12 to 15.

The regions of cerebral wasting 1 in dementia paralytica are, in the experience of the writer, little, if anything, different from those occurring in ordinary dementia (see pp. 472-3), but, especially in the left hemisphere, Broca's convolution is equally or more affected than the posterior third of the first and second frontal convolutions (see In many cases also parts of the parietotemporal region are more wasted than the sensori-motor area. As in ordinary dementia, the ascending frontal and ascending parietal convolutions may appear to show little wasting, but this is, perhaps, deceptive, as these convolutions are normally so large and so regular in shape. It is probable that this difference in order is due to the fact that in chronic dementia paralytica the wasting may be more extreme and rapid even than in ordinary gross dementia, and gives consequently, perhaps, the more correct differentiation. (See pp. 537 and 559.)

The lateral ventricles are dilated, and often extremely so,

See, in conjunction with this account, figs. 11, 16 and 17, Plates III. and V., and also figs. 6 to 10, Plates III. and III.

and with the third are much more frequently granular than are these regions in ordinary severe dementia. The fourth ventricle, however, shows, as a rule, perhaps, the most characteristic naked-eye sign of the disease. Whilst granularity of the lateral sacs is common in all varieties of insanity, and the granules may also occur on each side of the mid-line in the upper half of the lozenge, they rarely or never occur in the lower half or calamus except in dementia In this disease, even if the granularity is paralytica. general, it is usually most marked in the lower half, and it very frequently occurs here alone. A possible explanation of this has already been given in the section on the pathology of dementia. This statement may seem very definite, but it is founded on considerable clinical and pathological experience, and the writer is convinced of its accuracy. In certain aged patients (who long ago had suffered from syphilis) dying of gross dementia following severe vascular degeneration, and diagnosed cases of "senile dementia paralytica," the morbid anatomy is frequently that of the former and not that of the latter variety of mental disease.

The basal vessels frequently show no obvious naked-eye abnormality, but in many cases they are dilated and irregularly thickened owing to a pearly-white fibrosis. are less frequently calcareous. These appearances resemble the dense, almost cartilaginous, pearly-white fibrosis of the often-dilated aorta which is frequently present, and which, in the experience of the writer, is practically diagnostic of previous syphilitic infection, representing as it does an intense reparative reaction to previous severe injury, and being not improbably similar in nature to the dense and intractable strictures which frequently follow syphilitic ulcerations. In the case of the arteries also, dilatation frequently occurs owing to the pressure of the contained blood. The calcareous deposition in cases of ordinary senile vascular degeneration is probably due to the exceedingly feeble reaction of repair in these cases.

It is finally, perhaps, worth while in this description to draw attention to the appearance of a cut section of the cortex cerebri in dementia paralytica. The cortex is thinned,

and has a peculiar dark, translucent, and congested appearance, which is, as a rule, highly characteristic, though not peculiar to the disease.

General Pathology of Dementia Paralytica.

As has been stated in the section on etiology, in the opinion of the writer, dementia paralytica is a progressive dementia occurring in a syphilised actual or potential lunatic possessing the type of hereditary neuronic insufficiency which is prone to premature degeneration. The comparatively rapid fatal result in paralytic dementia is on a par with that seen in cases of gross senile dementia of the same type resulting from extensive vascular degeneration (see pp. 486-7 and 503-5). Dementia paralytica differs from the ordinary dementia already referred to in the following particulars:—

- (1) Vascular changes, which are almost to be described as a premature senility with an unusually active reaction of repair, are produced in the encephalon of the actual or potential lunatic by the syphilitic poison. These changes occur more or less generally, but are especially marked and progressive in the regions of hereditary neuronic insufficiency.
- (2) Certain other syphilitic sequelæ (which may occur quite apart from dementia paralytica, and are possibly due to a special selective affinity of the virus for certain neurones, especially if these are congenitally deficient or are subject to stress), may be introduced, especially (a) Argyll-Robertson phenomenon, possibly from premature decay of the first retinal afferent neurone amongst other factors (see (b)), and even marked or total primary optic atrophy; (b) premature decay (chiefly of the central portions) of the first afferent neurones of the lower limbs [(a) and (b) may be homologous phenomena and may be predisposed to by constant and excessive exercise of the parts involved]; (c) premature decay of the great efferent system of cortical neurones, frequently associated with epileptiform convulsions during the progress of the degeneration.

The reparative syphilitic sequelæ, referred to under (1), may not essentially differ from certain syphilitic sequelæ in

other parts of the body, e.g., the pearly-white fibrosis of the aorta and larger vessels and the more generalised syphilitic arteritis of the smaller vessels, the increased density of the solid viscera, especially the spleen, liver, and kidneys, and the general tendency to hypertrophy of the binding tissues of the body as a whole, at the expense of the more highly organised protoplasm (quite apart from the development of definite gummatous growths), the whole process being a reaction in the direction of repair against a powerful protoplasmic poison. The degree of injury and the consequent severity of the reaction of repair may in some cases be intensified by the mercurial poisoning which is frequently a part of the treatment of primary syphilis and which would also on its own account have this effect. The writer has frequently been informed by patients that they must have been cured of their syphilis owing to the large amount of mercury which they took during their course of treatment.

All the syphilitic sequelæ referred to may exist without causing dementia in either a normal person, or a potential or actual lunatic, provided that the hereditary insufficiency of the cortical neurones is of a type not prone to degeneration (see Cases 17 and 204).

On the other hand should the potential or acute lunatic possess a neuronic insufficiency of one of the types prone to degeneration, two factors are required in addition before dementia paralytica can be evolved, namely:—

- (1) Syphilisation, and probably this alone, as no other equally potent and insidious or at any rate equally common protoplasmic poison is known; and (2) Stress in the widest sense. (All varieties of worry and overwork; poisons like alcohol, lead, mercury, &c.; the occasional autointoxication following child-birth, &c.)
- (1) Syphilisation is necessary and acts by producing premature senility, just as in later life ordinary vascular degeneration results in the final development of gross dementia in cases who suffer from moderate dementia or possess neurones prone to degeneration. The only difference between these two factors lies in the detail that syphilis by acting thus kills the patient as a rule before the normal limit

of life is reached, frequently by middle life and even occasionally in youth, whilst ordinary vascular degeneration develops and produces its effects at the end of life. It is, perhaps, hardly necessary to add that the degree of syphilisation in an important consideration, as is also the treatment to which the patient is subjected, as these necessarily cause great variations in the severity of the reaction of repair which ensues.

(2) Stress, on the other hand, whilst necessary acts in a much more variable manner, the degree of this factor which is required varying with the resistance of the individual, and differing in the different types of the disease.

For example, in the highly organised and active neurones of the hard-worked and emotionally excited nervous system of the clever business man or speculator, with a hereditary taint often of a relatively slight character, but none the less existent, "stress," in which is included alcoholic excess, &c., plays a large part, and when the breakdown comes it is severe and rapid, and the typical "general paralytic" of the text-books is evolved.

If, however, the hereditary insufficiency is more pronounced, and especially if the subject is a marked degenerate, little "stress" is required, the patient soon enters an asylum, in which even the slight "stress" which has been the cause of his breakdown is removed, and the case frequently becomes a slow or even a very chronic one, the patient lasting a large number of years.

Finally, in the case of the pronounced degenerates, from whom the types of juvenile dementia paralytica are derived, two definite varieties exist:—(a) the higher class, where the patient can sustain his environment up to or beyond puberty, and may even be highly endowed mentally; he then breaks down after a longer or shorter interval, and progressive dementia supervenes; and (b) the lower class of pronounced aments who break down about puberty, even when under asylum régime, the cortical neurones being unable to live longer without degeneration, apart from even the slightest "stress." This latter class of case appears as a rule to be more chronic than the former, though of course intermediate grades exist.

It may be added that as "stress" is necessarily a more important factor in men than women, owing to the conditions of civilised life, so in accordance with this the rapid types of the disease in high degenerates are more common in the male than the female sex, whilst, in the case of the more marked degenerates, both sexes are equally affected.

Relative action of the different factors in the production of the disease.—It is not improbable that the deficient vitality or durability of the cortical neurones, together with the "stress" to which they are subjected, are chiefly responsible for the neuronic degeneration of dementia paralytica, and for the time of actual breakdown, and that former syphilisation is largely concerned with the amount of vascular and neuroglial change present in any individual case, though each factor necessarily reacts on and intensifies the other, thus causing an irregular, but on the whole steady, advance of the disease. These changes do not appear to bear any clearly definable relationship to one another, sometimes the one, and sometimes the other being the more pronounced, especially the latter, in adult cases of the disease; and in view of the impossibility, at any rate at present, of definitely determining with any certainty either the durability of the neurones, or the former severity of syphilisation, and the actual amount of repair reaction which exists, this question must for the present at least be left in abeyance. interaction of the factors is, however, undoubtedly the cause of the steady progress of the disease, as is also the temporary prominence of one or other factor the cause of the acute exacerbations which occur, for example, when temporary recovery is followed by a severe relapse, if the patient be discharged on trial and "stress" thus introduced. Certain suggestive facts will now be referred to. The widespread pearly-white fibrous repair tissue, which exists in the vessels, and is especially visible in the aorta, of many of the subjects of former syphilis, and which apparently takes the place of, and appears approximately in the sites of the usual calcareous atheroma of degenerate senile vessels, is confirmatory of the great amount of damage which has been done to the vascular system by the syphilitic virus. It also shows, as would, à priori be expected, that the repair reaction in the subjects of

syphilis is greater than that in senile persons, where the loss of tissue due to degeneration has to be largely closed by calcareous deposit. Both general thickening of the vessels and aneurismal dilatations at the resulting fibrous scars are consequently frequent in the ordinary subjects of syphilis. The writer is thus not making a very unreasonable suggestion in stating that probably the bulk of the chronic vascular changes in dementia paralytica represents the reaction of these tissues to a previous and also perhaps, in some early cases, still persistent injury by the syphilitic virus, and is hence of the nature of extensive and slowly growing (and overgrowing) scar tissue, the regions of its greatest development depending on those of greatest injury. Neuronic degeneration then occurs pari passu with the increasing growth of the repair tissue, which latter becomes more neuroglial in nature as the disease progresses. This latter does not occur in sane individuals, as the primary factor, deficient durability of the cortical neurones, is absent. The writer does not wish to suggest that the poison of syphilis has no action on the deficient cortical neurones of the potential subjects of dementia paralytica, but he certainly considers this to be relatively unimportant, and particularly so as such a long interval often occurs between infection with syphilis and the onset of dementia paralytica, during the whole of which time a slow growth of repair tissue may, however, readily be taking place. As occurs in the case of other highly metabolic organs, it is probable that syphilitic infection temporarily interferes with the normal activity of the cortical neurones, and it is not unlikely that an alienist might find the treatment of the subjects of recent syphilis an interesting study, In this connection the relatively recent onset of symptoms of cerebral syphilis, and their usually ready reaction to appropriate treatment, are worthy of mention, as in both these points cerebral syphilis forms a marked contrast to dementia paralytica, which appears considerably, and in many cases several years, later, and even in its early stage is absolutely intractable under anti-syphilitic treatment, as would be expected were the views correct which are expressed above.

PART II.

SUMMARY OF CONTENTS.

Interduction.—Classification of Mental Diseases (p. 546). General Histology of the Cerebral Cortex:—

- (I.) Method (p. 553).
- (II.) Functional Regions of the Cerebrum (p. 554). (a) Primary Afferent Areas (Type—Visuo-sensory region). (b) Lower Associational Areas (Type—Visuo-psychic region). (c) Higher Associational Area (Type—Prefrontal cortex across the transverse fissure of Wernicke, including part of the middle frontal convolution and part of the orbital surface of the anterior pole of the hemisphere).
- (III.) Abstract of a Previous Research on (a) and (b) (p. 555).
- (IV.) Prefrontal Cortex (p. 558). (a) General Structure and Special Method Adopted. (b) Micrometric Examination of Twenty Cases;
 (1) Normal hemispheres, Cases 1-3 (p. 565); (2) Normal aments (feetuses and infants), Cases 4-8 (p. 571); (3) Congenital aments, Cases 9-12 (p. 579); (4) Chronic insanity without dementia, Groups I. and II., Cases 13-15 (p. 590); (5) Insanity with marked dementia, Group III. and IV., Cases 16-17 (p. 598); (6) Gross dementia, Cases 18-19 (p. 600); (7) Gross dementia paralytica, Case 20 (p. 608).

CONCLUDING SECTION AND SUMMARY (p. 610).

Introduction.

CLASSIFICATION OF MENTAL DISEASES.

The provisional classification of mental diseases here advanced is the natural sequela of the subject matter of the first part of this paper, and, as will be seen, it is supported by the conclusions drawn from the study of the general histology of the cortex cerebri, at which subject the author has been engaged for upwards of six years, and to which the present division of the paper is devoted.

The highest cortical neurones of the subjects of mental disease may be either incompletely developed or insufficiently durable, or may suffer from both these disabilities. The term "amentia" is used throughout this paper to, in the widest sense, connote the mental condition of patients suffering from deficient neuronic development; the term "dementia" similarly connotes the mental condition of patients who suffer from a permanent psychic disability due to neuronic degeneration following insufficient durability.

Amentia.

This term thus refers to a developmental deficiency which may appear either with the dawn of psychic life, or at such critical periods as early childhood and school-life, puberty, adolescence, marriage, maturity, childbirth, the climacteric, &c., at any one of which the degenerate may fail to respond normally to his or her environment, and may show his or her inherited deficiency. Except in the cases which show early signs of mental deficiency (idiots and imbeciles), apparently complete recovery of a permanent or a temporary nature may occur, a stationary condition of insanity without appreciable dementia may follow, or at once or later a varying degree of dementia may ensue. In the case of the first two sequelæ post-mortem examination of the patient shows no abnormality of the intracranial fluid or membranes, apart from those associated with the local or systemic diseases which are the cause of the fatal issue.

Varieties of amentia.—(a) All idiots and imbeciles, whether primary or secondary. (b) Paranioacs, or cases with fixed and systematised delusions who do not develop more than mild dementia. (c) Cases of recurrent insanity not liable to develop more than very mild dementia, even in some instances in the presence of extreme vascular degeneration. (d) Cases of chronic insanity without visible dementia, chiefly single women, of the dangerous and excited or "moral" type. (e) Cases of "hysteria" in the widest sense. (f) Cases of true epileptic insanity (see later).

Mental Confusion.

By this term is connoted a symptom-complex which occurs in many acute cases of insanity, and in which the prominent features are defective knowledge of time and place, more or less complete inability to retain impressions even when these are frequently repeated, illusions of identity such as the mistaking of total strangers for acquaintances or friends or relatives, owing apparently to chance resemblances, and not unfrequently an inability to attend to the calls of nature, &c. An indication of mental confusion may also

be seen in the rapidly varying and quite unsystematised "delusions" which occur in many early cases of dementia paralytica, and in the many obsessions of which such patients are guilty.

Very frequently this symptom-complex is an important prognostic criterion, as it probably precedes all dementias, excepting the mildest, and it is, to say the least, extremely doubtful whether any patient recovers from severe mental confusion without a certain degree of weakmindedness ensuing.

The chief causes of mental confusion appear to be: -

(1) Direct action of toxines, especially alcohol and those of childbirth. In these cases, even when severe, almost complete or apparently complete recovery frequently occurs, and persons with relatively normal cerebra may probably be affected. Under this class should probably be included many cases of epileptic confusion.

¹ The following extracts from two of the writer's mental states are good examples of the type of mental confusion referred to:—

(1) "Patient has been married twelve years and has one child aged 10 years, a girl (she is adopted and is not his child). She is a professional player on the piano and the harp and every instrument. Patient is worth thousands, and millions, and made it by mining in Australia. He would be glad to take me on a sea voyage. He has three or four yachts of his own, very large ships. He is a strong man and can do 'anything, don't matter what. I am a butcher by trade and a beveller and silverer.' He has done racing, backing Arab horses. He has always backed them for a million. He has hundreds of horses, wild animals and everything. I shall soon see if I come down to his place. He has the finest house ever built, all bevelled plates and embossed work. It is an enormous size and everything is made of gold, shoes and everything else but the bricks, and these he could coat with it. He is a runner and jumper and can jump about six feet and has got several prizes. Could run fifteen miles in twenty minutes."

got several prizes. Could run fifteen miles in twenty minutes.

(2) "Patient knows neither day nor date nor when he came, though it is only two days ago. He is Sir Frederick William M., the Emperor of the world. Every place in the world belongs to him. He says he bought this place yesterday for a million millions, and then mutters millions, trillions, &c., to himself.

All the officials here are his friends. He and Dr. M. (name unknown) are great friends and are always together. He has seen him in the corridor this morning.

He is married and every child in the world belongs to him and his wife. She is the most handsome woman in the world, a most beautiful lady, Empress of the world, and was a M. Her family is very large, as so many were born. They were always taken to Marlborough House. The Princess of Wales and the Queen, and all the Nobility are all his wife. There are thousands of himself and his wife, but only one Emperor of the world—himself.

He got 'clap' when eight years old from a 'beautiful servant Kate' and was shown to everyone in the hospital as a prodigy. He explains that it was not really early, as 'when children are born now they are born him, and are fifty years old and know everything.'

I ask him to say 'rural artillery.' He at once says it as if he did not understand it, and immediately adds that he speaks all tho languages in the world."

(2) Indirect action of toxines, together with resulting deficient nutrition of the cortical neurones. (a) By vascular and neuroglial (and chiefly secondary neuronic) changes which follow prolonged action of the toxine, and are probably largely of the nature of secondary proliferation after, or of reaction to, the injury produced by the toxine. The chief, if not the only variety under this heading, is the dementia paralytica (which see), which is a frequent sequela of systemic syphilis in degenerates, and which rapidly or slowly passes on to a fatal issue. (b) By the vascular degeneration of senility or premature senility, which similarly results in secondary toxic and nutritional affection of the cortical neurones. In cases of this type also the dementia which supervenes progresses rapidly or slowly till death ensues.

Onset of Insanity.

As in the highest grades of pure amentia, so in all cases associated with mental confusion, the time of onset of the attack (i.e., when the potential lunatic becomes an actual one) depends on "stress" in the very widest sense, and including the causes of mental confusion enumerated above. The "stress" required may be slight, as when the hereditary disability is marked, in which case the patient rapidly enters an asylum, and either recovers often only to relapse, or remains a permanent inmate; or it may be extremely great, as in the highest psychopaths, where syphilis, alcohol, a generally irregular life, and the severest business strain and worry may be needed, in which case an extremely rapid case of dementia paralytica is likely to ensue; or any intermediate degree may be necessary to determine the breakdown.

Dementia.

In the more lowly aments the neurones are apparently stable, and their functional power is so slight that "stress" cannot intervene to any extent, and consequently these cases do not develop dementia. On the other hand, in higher degenerates of any grade it may almost be considered a general law that the higher the development of the neurones

the greater, or at any rate the more rapid, is the progress of the dementia which results when "stress" has determined the time of onset of the insanity. Until senility occurs, or apart from vascular changes due to whatever cause, the dementia is never severe, the ordinary chronic lunatic being the common result.

Varieties of dementia.—(a) Senile dementia or the dementia of worn-out neurones, which may occur primarily (see page 486), but usually follows on the development of gross vascular degeneration. This variety of dementia progresses till death occurs, and frequently develops in chronic lunatics on the supervention of vascular degeneration. (b) The dementia of degenerates who, owing to "stress," have become insane. Apart from vascular degeneration, however induced, the dementia is only moderate in these cases. This class includes all the ordinary and the primarily toxic (see (1), page 548) insanities, dating from puberty to the climacteric period, and in whom insufficient neuronic durability with or without deficient neuronic development exists. (c) The dementia of degenerates which is associated with premature (as a rule) vascular degeneration following "congenital" or acquired syphilis (see page 517-9). In these cases the dementia progresses more or less rapidly to a fatal issue. For further details the reader is referred to the section on dementia paralytica (page 506).

As will be seen, the above classification only agrees generally with the grouping of cases in Part I. This is, of course, due to the fact that patients die at all stages of their mental disease, and it is relatively rare for a fixed mental and physical result to be achieved. For example, when senile vascular change occurs the moderate dement becomes a gross one.

The Relation of Epilepsy to Insanity.

Epilepsy is a disorder of certain cortical neurones other than the highest. It is in many cases a coordinate of mental disease rather than a precedent or a consequent, and depends on the same primary (and secondary) causes. The relation of epilepsy to insanity is well seen on study of the family histories of these diseases. It is, for example, not uncommon to find epilepsy in one member of a family and insanity in another, or to find insanity in the descendants of epileptics, and sometimes vice versâ.

Epilepsy may occur apart from insanity, as insanity may occur apart from epilepsy. Very many epileptics are cured, even after suffering for years, and never show very recognisable mental symptoms, and the majority of lunatics are not epileptics.

Epilepsy may exist as part of the symptomatology of a certain variety of high grade amentia (see later).

Epilepsy may exist as the primary, a concurrent, or an accidental factor in any case of mental disease from the lowest degenerate to the highest. In many severe aments it is difficult or impossible to decide whether the amentia or the epilepsy is the primary factor, or whether the two are concurrent results of a primary developmental or accidental cause. In other cases, however, the fits precede recognisable mental symptoms by years, and it is not unusual to find progressive mental degradation associated with frequent and severe epileptic fits. Apart from such important factors as the modified reaction and chemical constitution of the blood of epileptics and the medical treatment to which they are subjected, the circulatory disturbances associated with the fits cannot be without effect in assisting to produce degeneration of the highest neurones of epileptics suffering from ordinary insanity, and consequently a progressive dementia. On the other hand, many patients may be chronic lunatics for years, and then develop typical epileptic fits without showing any post-mortem signs either of vascular lesions or of dementia paralytica. As, however, apparently typical epileptic, but often really epileptiform, fits may accidentally occur during the course of chronic insanity, and the patient may show at the post mortem definite vascular lesions of the kinæsthetic area which suggest that the earlier fits at least were Jacksonian in type, it is not impossible that the other cases possessed unrecognised vascular lesions which were the cause of the fits. On the other hand, however, in view of the fact that alcoholics and

syphilitics (who are not cases of dementia paralytica) may develop epileptic fits, it is perhaps not impossible in many adult cases that epilepsy may develop as the result of simple toxic instability of the neurones concerned.

It is thus by no means unjustifiable to consider epilepsy a cortical disorder which may exist alone, which may exist as part of the symptomatology of a special variety of high grade amentia, or which may be associated with ordinary mental disease, though when the two are concurrent the progress of the latter in the direction of dementia is in many cases hastened, and especially so in cases which are not well-marked aments.

True epileptic insanity. A high grade amentia.—A large number of epileptics in and out of asylums are best grouped in a separate class as cases of "epileptic insanity." These patients seem to form a class apart from ordinary mental disease, the sufferers from which are in the gross characterised by extreme selfishness, by callousness as regards others, and by an utter absence of self-consciousness. On the other hand, the group of epileptics under consideration seems to bear a more close relationship to the classes of criminals and criminal lunatics. These patients herd together, combine together against attendants, assist one another to attempt to escape, generally foment disturbances and quarrels with other inmates, and altogether possess an individuality quite different from that of the sufferer from ordinary mental disease. A rudiment of the same condition is seen in many low-grade epileptic aments, who generally are more spiteful and more degraded in their habits than other similar but non-epileptic aments.

It is hence probable that a distinction should be drawn between cases of mental disease in which epilepsy is a subordinate concurrent complication, and which, as a result of the epilepsy, frequently progress steadily towards more or less severe dementia, and cases of epilepsy in which the highest neurones are relatively normal, but where, concurrently with the actual or masked fits, there exists a degraded rather than a degenerate condition of quite a different nature, which has as its basis not so much an

affection of the intellect as a perversion of the instincts and emotions. This group has been placed under the heading "amentia."

GENERAL HISTOLOGY OF THE CEREBRAL CORTEX.

METHOD.

The method employed has been as a whole that made use of in a previous research, which will be referred to. Owing, however, to the larger number of cases included and to the relatively smaller region examined in each case, it has been necessary to use the serial paraffin method, as it was important to accurately measure many selected sections from each block instead of, as in the other research, a few sections only, these being chosen in the latter largely with a view to orientation. The average thickness of the sections was 10μ , and, according to the case, every tenth to thirtieth section was used for measurement.

The sections were mordanted in a two-thirds saturated solution of potash-iron alum for the necessary period, which largely varied with the case examined, feetal brains, for example, only requiring a few minutes. They were then stained for a similar variable period in a 1 per cent. aqueous solution of hæmatoxylin containing a little alcohol for preservative purposes, and differentiated in a 2 per cent. solution of nitric acid, being afterwards left in tap-water till blue, and then mounted in balsam. In certain of the cases, particularly in Case 20, a few duplicate methylene-blue or polychrome specimens were prepared by the Nissl method. Duplicate nerve-fibre preparations were not prepared, as these are not needed for lamination work, though they were useful for purposes of localisation in the previous research.

The measurements were made on the system hitherto employed, namely, with a No. 2 Zeiss eyepiece micrometer and an A objective with the drawtube at 160 mm. All the average measurements were then multiplied out into millimetres by the constant (01473) of this particular combination. It is perhaps hardly necessary to state that this constant varies somewhat in the case of different lenses of

the same make, which are nominally of the same magnification. In a certain number of instances, notably in Case 2, the measurements were compared with a series taken with a D objective, without, however, any real advantage, as what is gained in magnification is lost in definiteness in cases where the lamination is ill-defined, as occurred in the fœtus referred to.

The exact region of the cortex made use of in the twenty cases described will be detailed in the appropriate place.

FUNCTIONAL REGIONS OF THE CEREBRUM.

From the standpoint of function the cortex cerebri may be subdivided into three groups of functional regions.—
(1) Those regions to which afferent sensorial impressions primarily pass, namely, the kinæsthetic,¹ visual, auditory, &c.; (2) The lower associational regions concerned with the elaboration of these impressions, namely, the visuo-psychic (posterior region of the hemisphere, the angular and post-parietal gyri, the upper half of the cuneus, the lower half of the lingual lobule), the auditory-psychic (supramarginal gyrus and parts of the temporo-sphenoidal lobe), &c.; and (3) The region for higher association and coordination, namely, the anterior two-thirds of the first and second frontal convolutions and the neighbouring parts on the median aspect of the brain, and the anterior part of the third frontal convolution (see pages 472-3 and 559).

sensation may pass largely to the region of the superior parietal lobule, and be then elaborated in the sensori-motor area (the ascending frontal convolution, Broca's convolution, and the posterior one-third of the first and second frontal convolutions), the latter being under these circumstances the "psychic" or lower associational region for kinæsthetic impressions. If this should turn out to be the case, a lesion of the sensori-motor area would be homologous with one causing, say, word-blindness, and a lesion of part of the superior parietal lobule with one, say, of the visuo-sensory area causing partial hemianopsia. In view also of the facts that the inner and lower temporosphenoidal convolutions and the orbital surface of the frontal lobe are only slightly affected (pp. 472-3 and 536-7) even in the grossest cases of cerebral wasting in mental disease, and that Flechsig's second system of centripetal fibres (developed at birth) pass at any rate to part of these regions, it is possible that these areas, which are thus of little "psychic" importance, are concerned with the reception of the remainder of the fibres of general sensation. The results following ablation of the gygus fornicatus and the gyrus hippocampi, though in themselves inconclusive, point in the same direction.

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Examples of groups (1) and (2)—namely, the visuosensory and visuo-psychic regions of the cortex—have been fully considered in a previous communication, and, consequently, only need the shortest reference here. Region (3) will, however, be fully considered, and the results of an examination of twenty cases of various types will be described. For the purposes of the present paper, as will appear later, the depth of the pyramidal layer of nerve-cells is of prime importance, as it bears a definite relationship to the mental condition of the patient, though the other layers will necessarily be referred to.

(1) & (2) Visuo-sensory and Visuo-psychic Regions of the Cortex.

These areas are considered here as types of the afferent sensorial and lower associational regions of the cerebral cortex which have been referred to above, owing to their being the parts of the cortex cerebri with which the writer is especially familiar.

The former region has in a previous research been accurately mapped out in six cases, normal or suffering from longstanding or congenital blindness, and occupies a definite anatomical situation at the posterior pole and on the neighbouring inner surface of the hemisphere. For complete details the reader is referred to the above paper.

The lamination of the visuo-sensory region is as follows:—(I.) The superficial area of nerve-fibres. (II.) The layer of small pyramidal cells. (III.a) The outer layer of granules. (III.b) The middle layer of nerve-fibres or line of Gennari (containing solitary cells of Meynert). (III.c) The inner layer of granules. (IV.) The inner layer of nerve-fibres or inner line of Baillarger (containing solitary cells of Meynert). (V.) The layer of polymorphic cells.

In congenital or longstanding blindness the depth of Layer III.b is decreased by nearly 50 per cent., and that of Layer III.a by more than 10 per cent., owing to atrophy of the optic radiations, the other layers being unchanged in depth by blindness (see fig. 1, p. 557).

¹ Phil. Trans., 1900, pp. 165-222.

The lamination of the visuo-psychic region is as follows:
—(I.) The superficial area of nerve-fibres. (II.) The layer of small and large pryamids. (III.) The layer of granules. (IV.) The inner layer of nerve-fibres or inner line of Baillarger (containing large and frequently solitary cells). (V.) The layer of polymorphic cells (see fig. 1).

At the periphery of the visuo-sensory area, where it passes in each direction into the visuo-psychic, an abrupt change in lamination takes place, Layer III.b, the line of Gennari, suddenly ceasing, and Layers III.a and III.c, the two layers of granules, running into one, and becoming Layer III. of the visuo-psychic region.

Congenital or long-standing blindness causes no modification of the lamination of the visuo-psychic region.

The "outer line of Baillarger" or the "super-radial fibres," is not a layer in the sense referred to above, but in sections stained to show nerve-fibres appears as a thin band lying approximately at the outer trisection of the layer of large and small pyramids. The "line of Gennari," often called the "line of Vicq d'Azyr" and sometimes the "outer line of Baillarger," is not to be confounded with this line as it is a special layer of the cortex peculiar to the visuosensory area, and it constitutes the site of termination of the optic radiations.

The "inter-radial fibres," again, do not form a *layer* of the cortex. The name is applied to the meshwork of more or less transverse fibres which lie between the radiations or columns of Meynert.

Finally, the "tangential system of fibres" does not constitute a *layer* of the cortex in the above description, but lies in the outer or superficial part of Layer I., that of "superficial nerve-fibres."

These short remarks are introduced owing to the confusion which exists regarding the lamination and the fibre-systems of the cortex. Much of this has arisen because different observers have, whilst working with different methods, described different regions of the cortex, and different parts of the convolutions, under similar names. A very marked illustration of this confusion is to be seen in the diagrams

Fig. 1.

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Note.—The micrometer measurements on which this table is based have been already published.—Phil. Trans., 1900, pp. 165-222.

The subdivisions from above downwards refer to the cell-layers described in the text. In the first half of the table Layers III.a, III.b, and III.c, are bracketed together and are equivalent to Layer III. in the second half, which has a bracket opposite to it.

published by Dejerine in his text-book (vol. i., pp. 666 and 681), and reproduced by other authors.

In the above table (fig. 1, p. 557) are shown the relative depths of the pyramidal layer of nerve-cells in the six cases described in full in the previous paper.

On examination of this table it will be seen that in the visuo-sensory region of Cases 6 and 5, from infants aged one and three months respectively, the pyramidal layer is somewhat below the normal thickness, and that this layer is decreased also in Cases 2, 3, and 4, from patients suffering from chronic insanity with dementia. In the visuo-psychic region, however, whilst in the dements the pyramidal layer is decreased in depth to some extent, in the child of three months it is very much under-developed, and in the child of one month its depth is less than two-thirds of the normal.

In other words, in the visuo-sensory region of infants, aged one and three months, the pyramidal layer of nervecells is equally but not fully developed (in spite of the congenital blindness of the former), whereas in the visuo-psychic region it is much under-developed in the infant of three months and still more under-developed in the infant of one month. This fact constitutes an important proof of the associational function of the latter cortical region, and also indicates the relatively low "psychic" importance of the pyramidal layer of the visuo-sensory region. This latter fact is also obvious owing to the decreased development of this layer in the visuo-sensory region in the normal brain (about five-ninths) compared with that in the visuo-psychic region.

In the dements, however, the pyramidal layer is actually as much, and relatively to its depth more, decreased in the visuo-sensory region than in the visuo-psychic. This agrees strikingly with the fact that in dementia the loss of recognition and of recent memory is always more obvious than that of remote memory, though naturally little stress can be laid on this detail.

(3) Prefrontal or Highest Associational Region.

It has been proved in the first part of this paper that morbid changes found inside skull-cap in mental disease vary with the amount of dementia present and are otherwise independent of the duration of the disease.

As has already been stated (pp. 472-3) the regions of wasting (speaking generally) of the cerebrum in mental disease are as follows¹:—

- (I.) The greatest amount occurs in the prefrontal region (anterior two-thirds or so of the first and second frontal convolutions including the neighbouring mesial surface and the anterior one-third or so of the third frontal convolution).
- (II.) It is next most marked in the remainder of the first and second convolutions. (In dementia paralytica Broca's gyrus should as a rule be included here and II. and III. should follow IV., see pages 536-7.)
- (III.) It is perhaps next most marked in the ascending frontal and Broca's convolutions, though this in many cases at least should follow No. IV.
- (IV.) It is next most marked in the superior and inferior parietal lobules and in the first temporal convolution.
- (V.) It is least marked in the remainder of the cerebrum. It is not improbable that the order occurring in advanced dementia paralytica is really the more correct, as in certain cases of this disease the wasting is more rapid and pronounced even than in severe ordinary dementia, and the true differentiation may consequently be more exactly determined.

In the experience of the writer exceptions to this order are invariably due to vascular (or traumatic) causes, and should, therefore, be excluded.

Developmental Decrease.—Apart from abnormalities of development, which cases are necessarily excluded, the decrease follows the order given above, at least as regards Nos. I. and II. A further statement regarding this cannot be made owing to the relatively small number of cases occurring at any rate in an ordinary asylum, which show a decrease reasonably comparable with the marked wasting of dementia, as it is more usual to find small and simply convoluted cerebra than brains with average but small convolutions.

Functions of the prefrontal cortex.—From the above des-

^{&#}x27; See figs. 6-11, Plates II.-III., and figs. 16-17, Plate V.

cription of the cerebral wasting in dementia and of the cerebral under development in primary amentia, it is impossible to avoid the conclusion that the region grouped under Class (1) is the part of the cerebrum concerned with the highest functions of mind, namely attention and general orderly coordination of psychic processes. Experimental support of this thesis is to be found in the fact that the part of the psycho-motor area concerned with the movements of the head and eyes is situated just posterior to, if not partly within, this region; and the act of attention is invariably associated with fixation of the head and eyes. The following portion of this part of the paper contains histological proof of the same thesis.

For these reasons the extreme prefrontal region has been chosen for the purposes of the present investigation concerning the general histology of the part of the cortex cerebri which is concerned with the processes of highest association.

THE GENERAL HISTOLOGY OF THE PREFRONTAL CORTEX.

A full historical description of the visuo-sensory and visuo-psychic regions of the cortex cerebri was given in the previous paper. A similar account of the histology of the prefrontal cortex cannot, however, be inserted here, as this region has not hitherto been studied with the same minuteness. It seems, however, desirable to refer to the important monograph of the late Carl Hammerberg, "Studien über Klinik und Pathologie der Idiotie," which, though it deals with the cortex generally, contains several details bearing on the subject of the present section of this paper. The author in his monograph describes in detail the clinical histories and pathological appearances in nine cases of idiocy with a minuteness and an accuracy which are alike remarkable. The following short abstract of the cases he describes gives his conclusions so far as they bear on the subject of the present paper. The nine cases are divided into three classes: (a) four cases of absolute idiocy; (b) two cases of severe mental weakness; (c) three cases of slighter mental weakness.

(a) (1) Male, aged 22 months. Died of acute pneumonia. Apparently normal at birth. An absolute idiot. Reacted to

sounds and general stimuli. Not blind. Suffered from general convulsions from the age of three months. The brain was simply convoluted, and the hemispheres weighed only 65 and 66 grammes respectively. The prefrontal region was very small. There appears in this region to have been only a superficial fibre layer and a pyramidal layer of cells, with a partially developed spindle-cell layer below. The last is, however, better developed on the orbital surface of the lobe.

- (2) Female, aged 14 years. Died of acute pneumonia. Signs of mental deficiency were noticed at an early age. An absolute idiot. The case was apparently more severe than the last, as there was no reaction to external stimuli. There was paresis of the arms and paralysis of the legs, and the patient suffered from convulsions. The hemispheres weighed 138 and 218 grammes respectively, and the convolutions were somewhat small and simply formed. There was double porencephaly. There appears to have been in the prefrontal region a lamination similar to that in the last case.
- (3) Female, aged 10 years. Died of general debility. Symptoms appeared during the first year of life. Blind. Did not suffer from convulsions. The brain was fairly large, the hemispheres (hardened in Müller) weighing 492 and 481 grammes respectively. There was occipital microgyria. The prefrontal cortex seems to have been properly laminated, but in the posterior part of the inferior frontal gyrus only one layer of cells existed.
- (4) Female, aged 3 years. Died of acute pneumonia. No history. An idiot of low development. Could say one or two words. Head-nodding and choreiform movements. Sensibility decreased. Legs very weak. Distinct prefrontal lamination of the ordinary type existed, but the nerve-cells were undeveloped.

The salient histological features of these four cases were a decreased number of nerve-cells and an embryonic condition of those of the prefrontal cortex.

(b) (5) Female, aged 26 years. Died of general dropsy. Symptoms appeared about the third year. Mental power that of a five-year-old child. Clean and tidy. Fits during the latter years of life. The hemispheres weighed 352 and 372 grammes respectively. The arrangement of the prefrontal cell-layers was normal. The nerve-cells were small, and all the layers appeared to be thinner than normal.

- (6) Female, aged 22 months. Died of general debility. Born six weeks before time, owing to induction of premature labour. Athetosis when a few weeks old. Fond of playthings. Less developed than a child of the same age. Stammered a few simple intonations. Could not hold up her head or stand. Almost constant movements of the limbs, excepting during sleep. The hemispheres weighed 420 and 386 grammes respectively. The arrangement of cell-layers was normal. The nerve-cells were in general embryonic, and larger and less numerous than normal.
- (c) (7) Male, aged 14 years. Died of acute pneumonia. No history of onset. Could speak indistinctly at the age of four years. Showed more intelligence than Cases 5 and 6, and could learn a good deal. Could remember names, but could not calculate or read. Writing rudimentary. Complete paralysis of the legs, and paresis of the arms. No convulsions. The hemispheres weighed respectively 368 and 366 grammes. The anterior part of the left temporal region was absent. The cell-layers were well developed, but the cells were small. The depths of the layers and the number of cells are not referred to, and therefore no deviation from the normal was apparently noticed.
- (8) Male, aged 12 years. Died of miliary tuberculosis. No history of onset. Learned to walk and speak at the age of three years. Could neither read, write, nor adequately help himself. Could learn to perform slight tasks. Recognised persons and objects. Facial asymmetry and convulsions of face. The cortical cells were normal in arrangement, size, and structure, but the number of cells was less than normal, and the spindle-cell layer was especially poor in cells. The cell-nuclei were larger than normal, and there were numerous embryonic cells. As the depth of the cortical cell-layers is not referred to, it is probable that they appeared normal in this respect.
- (9) Female, aged 16 years. Never able to walk. Could only imperfectly learn to speak, read, or write. Mental progress fair. Speech defective, but partially intelligible. Could not write. Both legs paretic, and could not stand. Choreic movements of the limbs. The cerebrum was very large, and the hemispheres weighed 603 and 612 grammes respectively. The nerve-cells were normal in arrangement and size, but their number was less than normal. Numerous embryonic cells, as in the preceding cases, were present.

The nerve-cells of the cortex cerebri in the above cases were most carefully counted, and certain types of cortex and

of individual cells were carefully drawn to scale and described, the whole being compared with similar preparations of normal cortex. Whilst both the types of case made use of (these being pathological curiosities rather than cases of pure amentia) and the methods adopted differ from those employed in the present paper, the results are of sufficient importance to justify the above somewhat detailed summary.

The method adopted during the present research will now be described.

Whilst in the case of the visuo-sensory and visuo-psychic regions of the cortex a relatively large area of the cerebrum was examined in the six cases described, each of these requiring several months for completion, in the investigation to be described a much smaller area has been made use of in each of the twenty cases. Error from this source has, however, been decreased or obviated by most careful localisation of the cortex made use of, in order that it might be exactly the same in all, and also by repeating the measurements (which average some hundreds in each case) time after time in order to ensure their accuracy. The result has been, as will be seen in the tables of measurement contained in this section, that the averages are probably quite as correct as those made from the more extensive regions examined in the earlier research.

The cortex made use of was taken from the extreme anterior pole of the hemisphere across the (constant) transverse fissure of Wernicke. It included the anterior portion of the middle frontal convolution, and also a part of the orbital surface of the lobe. Serial paraffin sections were prepared in the manner described above, and every tenth to thirtieth section, according to the size of the hemisphere, was carefully measured, an attempt at almost mathematical accuracy being made. The personal equation may be considered constant, as the writer has during the past six years completed more than 100,000 micrometer measurements of the cerebral cortex, the major portion of which, including more than 20,000 of the earliest ones, were rejected owing to inaccuracy on repetition.

The lamination of the region under consideration is

practically identical with that of the visuo-psychic already referred to. It is not unusual, however, to find a larger number of more or less pyramidal-shaped cells in the fourth layer.

The cortical layers are as follows:—(I.) The superficial area of nerve-fibres. (II.) The layer of small and large pyramids. (III.) The layer of granules. (IV.) The inner layer of nerve-fibres which often contains a considerable number of pyramidal-shaped cells (inner line of Baillarger). (V.) The layer of polymorphic cells.

Regions of Convolutions capable of Accurate Micrometric Examination.

For micrometric measurement it is essential that the section should be perfectly vertical, and that tangents to the points of measurements between each two layers should be parallel to one another, otherwise constant and therefore accurate results are impossible. The regions of sections of convolutions in which the latter requisite is possible are, in the experience of the writer, only four in number. These are as follows:—(1) The sides of the convolution or the parts in contact within the fissures; (2) the apices or acute bends at the fissure lips; (3) the flat surfaces or portions of the convolutions lying on the external surface between two apices; and (4) the bottoms, or acute bends at the lowest point of the fissures. Only one apical (or two if a flat surface exists) and one bottom measurement are consequently possible in each convolution, but if the fissure be deep more than one side measurement can with care be made, and the same may be done in the case of the flat surface if the convolution is sufficiently broad, or is cut lengthways, as may occur in the case of the middle frontal convolution, which often meets the transverse fissure of Wernicke at a right In the tables of results given with each case, averages of these different series of measurements are introduced, and from these averages the general average depth is obtained. The last is used as the basis for the percentage measurements given on figs. 23 and 24 (pp. 613-4).

only necessary to add that the differences between individual measurements, not only in the several regions but in the same regions of the convolutions, are so great that in the majority of cases it is quite impossible to form even an approximate guess as to what the general average result will be until the measurements have been worked out.

The twenty cases made use of will be considered under the following groups:—

- (a) Cases 1 to 3. Normal hemispheres.
- (b) Cases 4 to 8. Five normal aments, namely, two feetuses of about four and six months respectively, two stillborn children (male and female), and one child aged six weeks.
- (c) Cases 9 to 12. Four congenital aments suffering from severe to slight mental deficiency. In Case 11 both hemispheres are reported on.
- (d) Cases 13 to 15. Three cases of chronic insanity without dementia; one from Group I. and two from Group II. of the first part of this paper.
- (e) Cases 16 and 17. Two cases of insanity with marked dementia. (Groups III. and IV.)
- (f) Cases 18 and 19. Two cases of gross dementia. (Group V.)
 - (g) Case 20. A case of gross dementia paralytica.

(a) Normal Cases.

Case 1.

History.—Female, aged 38 years. Died May 9, 1901. Housewife. Married. Eight children alive, five dead. Father suffered from fits for six years, and eventually died in one. Mother dead. Patient has had twelve brothers and sisters, of whom ten are alive. Patient has had no previous important illness. She was confined February 15, 1901, and a week later had a "white leg" on the right side for four weeks. From February 15, 1901, she had "stoppage of the inside" for a week. On March 3, 1901, pains again started in the stomach. She then was in hospital from March 30, 1901, to April 19, 1901, with symptoms of intestinal obstruction, and recovered. Was re-admitted May 3, 1901, and at once operated on. An obstruction due to bands was found, and

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enterectomy was performed. Death occurred in eighteen hours from general peritonitis. After hardening in formol the right hemisphere weighed 539 grammes, and the left 515 grammes, both unstripped.¹

Case 2.

History.—Male, aged 13 years. Stated to be deaf and dumb. Was killed in a street accident, and brought dead into hospital. The cause of death was hæmorrhage due to rupture of the spleen. After hardening in formol the right hemisphere weighed 577 grammes, and the left 568 grammes, both unstripped.

Case 3.

History.—Female, aged 36 years. Died May 8, 1901. Charwoman. Married three years. No children, no miscarriages, courses regular. No history of alcohol. Father, nine sisters and one brother alive and healthy. Mother died at the age of 60 years of cancer of the stomach. Patient had an illness causing pain in the lower part of the stomach in 1896. On April 1, 1901, the present illness began with pain in the abdomen, vomiting and constipation. She developed enteric fever, and died of acute nephritis and pneumonia. After hardening in formol, the right hemisphere weighed only 469 grammes, and the left only 465 grammes, both unstripped. The small size and the under-developed condition of the cerebrum, which at first led to the case being rejected as a normal, are interesting when compared with the table of measurements belonging to the case, which shows that they are below those of Cases 1 and 2. This case may very possibly have been one of potential insanity, and especially so as no history of insanity was looked for.

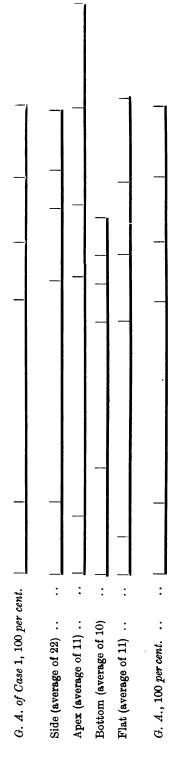
In figs. 2 to 4, pp. 567-9 are given the average measurements made from these three cases, none of which are likely, from the brain weight, age and sex point of view, to give results above the average; in fact, they are more likely to err on the other side. From an examination of these results it will be seen that both generally, and in detail, the measure-

^{&#}x27;In Cases 1 to 8 inclusive, the weights given, being taken after hardening in formol (see page 477 et seq.), are probably about 10 per cent. above the weights in the fresh condition. Hence in Cases 1 and 3 the weights should be at any rate about 500 and 430 grammes respectively (average normal 554), and in Case 2, 530 grammes (average normal 609). These normal cases are consequently likely to give results below rather than above the normal average.

Case 1.—Cortical measurements in mm. $(54 \times 5 = 270)$.

	Reg	tegions.				Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 22)	:	:	:	:	:	.27318	:	-92196	:	.24773	:	.17609	:	.24840
Apex (average of 11)	:	:	:	:	:	.21827	:	•99762	:	-29460	:	.38164	:	.43520
Bottom (average of 10)	:	:	:	•	:	.43895	:	.59215	:	.15319	:	.09133	:	.15614
lat (average of 11)	:	:	:	:	:	.17810	:	.83292	:	.26916	:	.29460	:	-36691
										.24117	:	-23592	:	30166
	G. A	, 1·89204 mm.)4 mm.	11	:	.27713	:	.83616	:			.77875		

Case 1.—Cortical measurements in percentage of General Average of Case 1.



Norm.—In this and the following tables the general average measurements (G. A.) are prepared on the basis that the regions of the cortex named "side," "apex," "bottom," and "fat," are of approximately equal extent. The number of measurements employed in any given case depends on the number which satisfy the necessary conditions (see p. 564), and is unimportant except from its bearing on the general accuracy of measurement of the particular region concerned.

The graphic representation of the figures which is given below each table is as accurate as the method of reproduction made use of will

permit.

Fig. 3.

Case 2.—Cortical Measurements in mm. (68 imes 5 = 340).

	-	Regions.						Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 33)	:	:	:	:	:	:	:	-27853	:	-86738	:	19104	:	13078	:	.22363
Apex (average of 12)	:	:	:	:	:	:	:	30074	:	1.18699	:	.30933	:	.39525	:	.50573
Bottom (average of 11)	:	:	:	:	:	:	:	.56911	:	.64678	:	.14328	:	.07633	:	.14864
Flat (average of 12)	:	:	:	:	:	:	:	-21727	:	-90467	:	.23445	:	·28846	:	.36334
												21953	:	-22271	:	·31033
		ය	A., 1.	G. A., 1.99541 mm.	am.	ii	:	.34141	:	-90143	·:			.75257		

Case 2.—Cortical Measurements in percentage of General Average of Case 1.

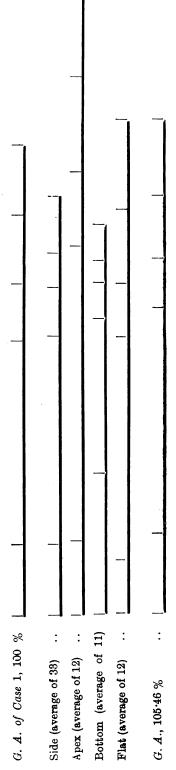


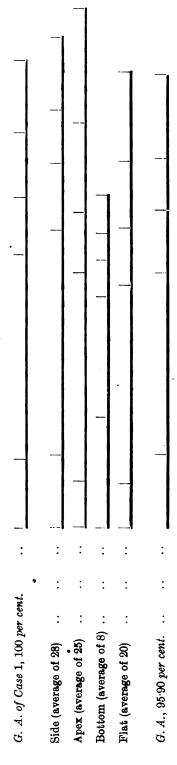
Fig. 4.

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Case 3.—Cortical Measurements in mm. (81 \times 5 = 405).

	Regions.					Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 28)	:	:	:	:	:	-29144	:	-93115	:	-25988	:	.21043	:	30144
Apex (average of 25)	:	:	:	:	:	19679	:	.81722	:	-24629	:	-96354	:	.44367
Bottom (average of 8)	:	:	:	:	:	44006	:	.49530	:	.15467	:	.08286	:	.15466
Flat (average of 20)	:	:	:	:	:	.20401	:	.77995	:	.24231	:	-27250	:	-36972
										.22579	:	-28288	:	.81737
	G. A.,	, 1.814	G. A., 1.81447 mm.	11	:	-28308	:	.75590	:			.77549		

Case 3.—Cortical Measurements in percentage of General Average of Case 1.



ments from Case 1 form an almost exact average of those of the three combined cases. Case 1 has, consequently, been used as an average normal, and on it the percentage table of the whole series has been based. A comparison of the total average depth of these three normal cases with that of the normal case used as a basis for the percentage measurements of visuo-sensory and visuo-psychic cortex on p. 557, will demonstrate the remarkably constant depth between certain small limits of the cortical cell-layers even in widely different parts of the cerebrum. If the actual or percentage measurements of these three normal cases be examined the striking fact is elicited that the variation between them is in the pyramidal layer of cells, Layers III., IV. and V. being of the same actual depth in each. In this important point the three normal cases fall in with the general conclusions drawn from the results obtained from the total series of cases, namely, that the depth of the pyramidal layer of nerve-cells varies directly with the mental power of the indi-It is, consequently, only fair to assume that the difference in the depth of the pyramidal layer in these normal brains is also associated with differences in the mental power of the individuals to whom they belonged. One other matter may be referred to in this connection. Of all the layers of the cortex the pyramidal layer is the easiest to measure correctly, and the remarkably constant, in fact almost identical, results which have been obtained in the case of the other layers of the cortex in these normal individuals is a convincing proof of the value of micrometric examination, when, by practice, the personal equation has become constant.

Of the whole series of cases examined, only one, Case 14, approximates to the lowest normal, and this patient was of the low and degraded rather than lunatic type, and suffered from little or no dementia. The heavy, sullen and stupid behaviour of this patient, a condition often mistaken for dementia, is a mental state by no means unusual in sufferers from chronic tuberculosis, and somewhat resembles the behaviour which would be expected to occur in a caged beast suffering from serious disease.

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Case 4.—Cortical Measurements in mm. (29 \times 2 = 58).

Layer V.					
Layer IV.			.		
ı.	.55974	-83961	.54501	.76596	.67758
Layer III.					
Layer II.					
Layer I.	13257	.14730	-20622	13257	154665
	:	:	:	:	:
	:	:	:	:	
	:	:	:	:	mm.
gions.	:	:	:	:	·832245 mm.
Regic	Side (average of 4)	Apex (average of 8)	Bottom (average of 4)	Flat (average of 13)	G. A., ·

Case 4.—Cortical Measurements in percentage of General Average of Case 1.

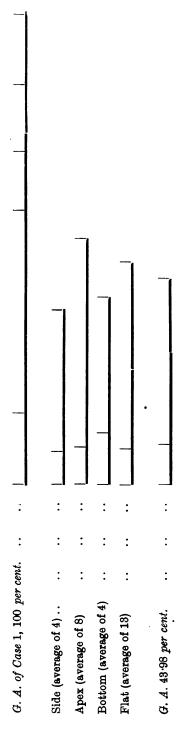


Fig. 6.

Case 5.—Cortical Measurements in mm. (20 \times 5 = 100).

Layer V.	-22095	
	:	
Layer IV.	.22095	-55974
	:	:
Layer III.	.11784	: :
		:
Layer II.		.22095
		:
Layer I.		.11784
		:
		II
		G. A., '89853 mm.

Case 5.—Cortical Measurements in percentage of General Average of Case 1.

	7
:	:
G. A. of Case 1, 100 per cent.	G. A., 47.50 per cent

F19. 7.

Case 6.—Cortical measurements in mm. (91 \times 5 = 455).

Reg	Regions.				Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 34)	:	:	:	:	13907	:	-43367	:	.14773	:	11697	:	.19279
Apex (average of 24)	:	:	:	:	17001	:	.58949	:	•20131	:	·287 52	:	.31424
Bottom (average of 16)	:	:	:	:	-26422	:	.27803	:	.09759	:	.04971	:	.09206
Flat (average of 17)	:	:	:	:	17936	:	.48436	:	16983	:	19149	:	-25734
									.15411	:	.14892	:	.21411
G	G. A., 1·13919 mm.	3919 m	m.	:	.18816	:	•43389	:			.51714		

Case 6.—Cortical measurements in percentage of General Average of Case 1.

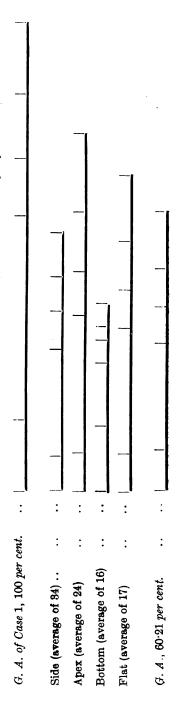
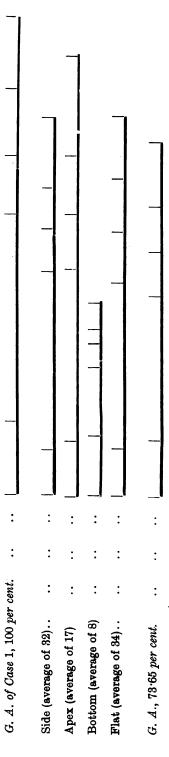


Fig. 8.

Case 7.—Cortical Measurements in mm. (91 \times 5 = 455).

Regions.				Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 32)	:	:	:	19149	:	.67988	:	-20254	:	$\cdot 19982$:	.25870
Apex (average of 17)	:	:	:	.21229	:	.68191	:	-22442	:	.27121	:	.34659
Bottom (average of 8)	:	:	;	-24857	:	-29828	:	06860	:	.05155	:	.08838
Flat (average of 34)	:	:	:	-21402	:	.64205	:	.19149	:	21272	:	-26557
								17809	:	.18370	:	-23981
G. A.,	G. A., 1·39372 mm. =	ii ii	:	•21659	:	.57553	:			.60160		
average of 34) G. A., 1		: " :	: :	·21402	: :	64205	: :	-19149	• • •		18370	18370

Case 7.—Cortical Measurements in percentage of General Average of Case 1.

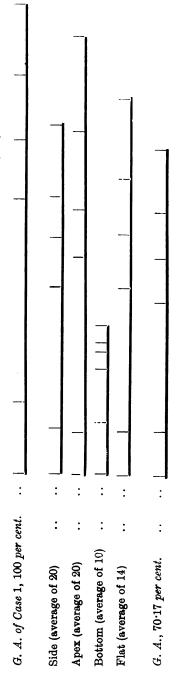


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Case 8.—Cortical measurements in mm. (64 \times 5 = 320).

Reg	Regions.				Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 20)	:	:	:	:	18928	:	.58404	:	.20327	:	16866	:	.26588
Apex (average of 20)	:	:	:	:	17308	:	.69894	:	-21506	:	.31817	:	.37120
Bottom (average of 10)	:	:	:	:	-21358	:	.20622	:	.07365	:	.04124	:	06776
Flat (average of 14)	:	:	:	:	17466	:	.59131	:	.20411	:	.23989	:	· 3 1038
									.17402	:	.19199	:	.25380
Ġ.	A., 1:	G. A., 1.32759 mm.	m. =	:	18765	:	· 5 2013	:			.61981		

Case 8.—Cortical measurements in percentage of General Average of Case 1.



(b) Normal Aments.

Case 4.

Male fœtus, aged a little over four months (see fig. 1, Plate I.). Weight of hemisphere, after hardening in formol, 32 grammes.

Case 5.

Fœtus, aged a little over six months (see fig. 2, Plate I.). Weight of hemisphere, after hardening in formol, 55 grammes.

Case 6.

Stillborn male infant (see fig. 3, Plate I.). Right hemisphere, after hardening in formol, 194 grammes; left hemisphere, after hardening in formol, 196 grammes.

Case 7.

Stillborn female infant (see fig. 4, Plate I.). Right hemisphere, after hardening in formol, 190 grammes; left hemisphere, after hardening in formol, 193 grammes.

Case 8.

Infant, aged six weeks, sex unknown. Died of marasmus. Whether this child was full-term or not, it is of course impossible to state. It is possible, however, in view of the feeble and emaciated condition of the child, that its cerebral as well as its general bodily development had been retarded. Weight of the left hemisphere, after hardening in formol, 161 grammes (see fig. 5, Plate I.).

In figs. 5-9 (pp. 571-5) are given the average results of the examination of these cases.

In Case 4 (four months' fœtus) (see fig. 1, Plate I.), whilst vascular fissures exist, as will be seen from the different regions of the convolutions which are measured, no development of lamination has occurred. The neuroblasts are undifferentiated, but a superficial layer of neuroglia exists, and into this irregular masses of neuroblasts project, which make it somewhat difficult to accurately estimate the absolute depths of the two layers.

In Case 5 (six months' fœtus) (see fig. 2, Plate I.) the lamination has just appeared, the separation of the neuro-blasts into layers being quite clear in some regions and very

obscure in others. The temporary (vascular) fissures have largely or entirely disappeared, and consequently all the measurements given are taken from the flat external surface. The actual depth of the cortex differs very little from that of the previous case, and it is not impossible that the development of lamination is coincident with and perhaps the cause of the disappearance of the temporary (vascular) fissures, for in view of the relatively great difference between the two brains (see illustrations) it is obvious either that something important in connection with the neuroblasts is happening in the later brain, or that there is no relation between the development of the neuroblasts and that of the brain as a whole, which latter possibility is contradicted by the facts contained in the remainder of this paragraph. In the later brain although the lamination is just appearing, the depth of the combined III., IV. and V. Layers is practically the same as in the stillborns, Cases 6 and 7, though Layer III. is narrower and Layer IV. is wider than in these cases. exceedingly narrow pyramidal layer, which averages only 22095 mm, in thickness, is the most striking characteristic of this case, and the different individual depths of the five layers compared with those of the later and those of the adult brains conclusively demonstrate the order of development of the cortical layers and also suggest their relative functional value, as, presumably, the later the development the relatively higher the function.

In Case 6 (stillborn male infant) (see fig. 3, Plate I.) the pyramidal layer has become nearly double its depth in Case 5, averaging 43389 mm., whilst the average of the other layers is unchanged, though they now bear the adult relation to one another, Layers III. and IV. being of practically the same depth, which is between two-thirds and three-fourths of that of Layer V.

In Case 7 (stillborn female infant) (see fig. 4, Plate I.) all the layers, whilst bearing the same relation to one another as in Case 6, are somewhat deeper, and this agrees with the facts that the brains of the two cases are of about the same weight though of different sexes, and that (see illustrations) the prefrontal region of the female brain is

obviously better developed than that of the male, which is an important coincidence of naked-eye and microscopic appearances in relation to the remarks made a little earlier concerning Cases 4 and 5. The obvious inference from Cases 6 and 7 is either that the brains of infants at birth, for both these cases were ordinary term stillborns, differ in their respective degrees of development or that the cerebrum of the female infant develops more rapidly than that of the male. That the former inference is the true one is supported by the writer's experience of the brains of infants and young children, which even when of about the same age differ extremely in the degree of their development. This is also suggested by Case 8 (a marasmatic infant) (see fig. 5, Plate I.), the cortex of which, though the child is six weeks old, is in most details almost the counterpart of that of Case 7. The hemisphere of this case is no less than 30 grammes lighter, weighing only 161 grammes, than that of Case 7. In the case under consideration cerebral wasting, in association with general malnutrition, may have occurred, or the infant may have been prematurely born, in which latter case the conclusion that extrauterine development is more rapid than intrauterine would be obvious. one point, however, Case 8 differs significantly from Cases 6 and 7, namely, in the greater development of Layers IV. and V. This not only agrees with the fact that the child was older than the others, but is suggestive of the function of the polymorphic layer of nerve-cells, as a child of 6 weeks has learnt little or nothing beyond what appertains to the lower animal functions. (See page 580 and fig. 24.)

Although these cases show that considerable variation exists in the degree of cortical development at a given age and that further exact study of the subject would probably be unfruitful, they strikingly illustrate the mode of development of the lamination of the cortex cerebri, which is really the only fact of importance. The measurements may be usefully compared with those of the visuo-sensory and visuo-psychic regions of the cortex of infants, aged one and three months respectively, which are given in abstract in fig. 1, page 557. This subject will be further referred to at the end

of this division of the paper; in connection with the results obtained from the study of the cortex in dementia.

(c) Congenital Amentia.

Cases 9 to 12 illustrate the general histology of (primary) amentia. Case 9 is an example of marked primary amentia, with an encephalon, however, of a size that is not much below the normal. Case 10, on the other hand, was capable of rudimentary education in spite of the fact that the total weight of the encephalon was only 660 grammes. As will be seen below, micrometric examination at once affords the explanation of this apparent contradiction. This case, as will be seen, was possibly one of secondary amentia. Case 11 was a more intelligent child, though she exhibited much mental deficiency. Case 12 was a high grade imbecile, of considerable education, who developed delusions and (probably secondary) hallucinations, and eventually a mild degree of dementia (Group II. of Part I)

Case 9.

Admitted November 11, 1893. Died January 7, 1901. Female, aged 36. No family history.

History.—In an imbecile asylum from 1878 to 1893, in which latter year she was certified. "Lost and melancholic, bursts into tears when spoken to, and declares she wants to go away with me, or that she wants to go back to the imbecile asylum. Very slow in answering questions, which is usually done in monosyllables. Is of weak intellect, and of defective memory. Is at times restless, excited, and noisy, and is spiteful and violent."

Course.—Imbecile in manner and appearance. Is of feeble mind. Can work a little, but usually sits about smiling vacantly. Is able to give but a poor account of herself. Says she used to be at D———, but was sent to the workhouse because she broke some glass. December 25, 1894.—Heedless of her surroundings. Childish and simple. July 12, 1895.—Rheumatic fever and endocarditis. January 18, 1896.—Drinks an enormous quantity of water if allowed to. No sugar in urine. Very troublesome and self-willed. April 4, 1896.—Bolts her food and steals that of others. Importunate when she wants anything. January 19, 1897.—Very restless, troublesome, self-willed, stubborn, and resistive. August 20, 1898.—Is simple-minded and childish.

Does a little needlework. Is always eating and drinking. February 23, 1899.—Impulsive at times, but as a whole good tempered. May 28, 1900.—Resistive and obstinate. Drinks gallons of water daily. July 25, 1900.—Legs ædematous. November 28, 1900.—Simple and childish. At times resistive and obstinate.—May 20, 1901.—In bed with heart disease and dropsy. July 1, 1901.—Died of morbus cordis.

Dura and S.D.—Natural. No excess of fluid. Pia.—Natural. Strips naturally. S.A.—No excess of fluid. Vents. L.—Natural. IV.—A few granulations in the lateral sacs. Vessels.—Natural. The brain is rather small but perfectly natural, except for slight simplicity of the convolutions and a somewhat decreased development of the prefrontal region. Weight of encephalon, 1,165 grammes. Weight of cerebellum and pons, 148 grammes. Right hemisphere, unstripped, 505; left hemisphere, unstripped, 500, stripped, 485.

Cause of death.—Morbus cordis. Adherent pericardium and aortic and mitral stenosis.

This case, in its general average measurements, is almost identical with Case 7 (a female stillborn). It differs, however, greatly in detail. The side measurements are considerably, and the bottom and apex measurements are somewhat, higher, whilst the flat surface measurements, except in the case of Layer V., are only from one-half to two-thirds the depth of those in Case 7. This extremely deficient development of the flat surface measurements, apart from the general decrease, is striking, as it does not occur in a single other case of whatever variety (see fig. 10).

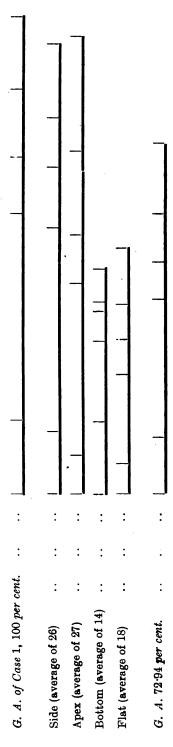
Whatever be the cause of this extreme decrease in depth of the four upper layers on the exposed surface of the cerebrum, its presence is sufficient to explain such a marked degree of mental deficiency in a patient with a brain of practically normal naked-eye appearances, and in which the average measurements of other parts of the convolutions point to severe but not extreme amentia. The absence of decrease in the fifth layer (polymorphic cells) is suggestive, for, as has already been shown, this layer is the first of the cortical layers to be developed, and it is consequently probable that it subserves the lower bodily functions, such as the control of the sphincters, feeding oneself, &c., and

Fig. 10.

Case 9.—Cortical Measurements in mm. (85 \times 5 = 425).

Reg	Regions					Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 26)	•	•	•	:	:	-25947	:	82941	:	-21755	:	-21075	:	28100
Apex (average of 27)	•	•	:	•	:	.16148	:	70322	:	20567	:	.34643	:	.41571
Bottom (average of 14)	•		:	:	:	29355	:	.84721	:	-09995	:	.05866	:	-09995
Flat (average of 18)	•	•	:	:	:	.12030	:	-36989	:	12848	:	.14566	:	-23077
										.16291	:	.18913	:	.25686
	O	3. A.,	1 -3800	G. A., 1·38003 mm.	II	.20870	:	.56243	:			06809.		

Case 9—Cortical Measurements in percentage of General Average of Case 1.



ability to behave generally in the manner of an animal which does not possess the higher powers of mentation.

Case 10.

Admitted April 18, 1896. Died October 29, 1900. Female, aged 24 years. No heredity of insanity.

History.—Fits since 9 years of age. Had an accidental blow on the head at school and after this gave way to fits of temper. Was not in an imbecile asylum. "Unable to talk sensibly and coherently on any subject. States that she has five heads. Does not know where she is or how long she has been in the ward. Has been in a dreamy, dazed condition during the past twelve days, and has had many epileptic fits. Does not know how to dress, undress, or wash herself, and has been very noisy and excited and violent after some of the fits, trying to bite and threatening to strike other people."

Course.—Keloids on right shoulder, scars of burns on forehead and chin, palate high and narrow, alternating squint, pupils normal, reflexes much exaggerated. Is childish, and very silly and stupid. It is difficult to get her to understand or to do what she is told, and her education is very deficient. She shams fits and lies down carefully on the floor. She knows her letters and can count. She can write her name, but cannot read, and cannot add simple numbers. She speaks like a child and says she likes to be at home to help her mamma. She says she has always had bad fits. She is easily lead and likes to be noticed. August 16, 1896. -Has had several severe fits each month, and is very troublesome, spiteful, and abusive. January 23, 1897.—Childish and at times very hysterical. Has about twelve fits a month. November 1, 1897.—Has lupus of the nose. March 16, 1898.—Childish and imbecile in appearance and manner. At times becomes abusive and spiteful and has great loss of control. September 17, 1899.— Lupus rapidly spreading. Has from one to thirty-two fits a month. February 21, 1900.—Lupus scraped and cauterised for the second time. September 25, 1900.—Face again scraped. October 29, 1900.—Died of broncho-pneumonia.

Dura and S.D.—Natural. No excess of fluid. Pia.—Natural. Strips naturally. S.A.—No excess of fluid. Vents. L. and IV., and Vessels.—Natural. The convolutions as a whole are of fairly normal complexity. There is marked microgyria in the upper third of the external surface of each hemisphere near the median fissure but not involving the median portion of the hemisphere. The cuneus is represented by a single simple gyrus, and the cuneal

annectant runs superficially into the cingulate gyrus. Total weight of encephalon, 660 grammes. Cerebellum, 115 grammes. Right hemisphere, unstripped, 263 grammes; left hemisphere, unstripped, 280 grammes. Left hemisphere, stripped, 265 grammes.

Cause of death.—Broncho-pneumonia.

In this case it is not improbable, in view of the absence of a hereditary history of insanity, and of the presence of the localised microgyria, that both the epilepsy and the amentia are secondary to some vascular or traumatic cause. the patient thus being really a secondary or accidental ament. This case does not seem to have been sufficiently troublesome to require removal to an asylum till the age of 20 years, but, as has been shown in the clinical notes, the mental deficiency was very marked. Except in the case of the side averages, the measurements, as a whole, are higher than in the previous case, and the total average depth is somewhat greater (see fig. 11, p. 584). Whilst in the former case, however, the greater deficiency in neuronic development was spread over a considerable cortical area, in which there was extremely marked decrease in depth, in this case the brain is some hundreds of grammes below the average weight, and possesses in addition an extensive local microgyria. These two cases well illustrate the two possible varieties of deficient neuronic development in severe amentia.

Case 11.

Admitted June 28, 1901. Died August 16, 1901. Female, aged 11 years. Maternal grandmother insane.

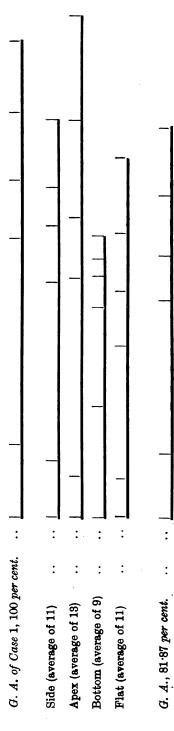
History.—Patient began to have fits six years ago, and had her last in 1896. She was always a loving and quick child. Was very cheerful, and full of play, and fond of using a slate and pencil or writing on a book, or looking at pictures. As a little child she would stray away from home, and be found at different police stations. She could never sleep at night. During the past five or six years she used to rock herself in bed and move her head backwards and forwards, and also tore up anything in the bed. From 1898 to 1899 she was in an imbecile asylum, and was then placed in a workhouse. "Does not know ordinary articles that are shown to her. Talks gibberish and does not answer questions

Fig. 11.

Case 10.—Cortical measurements in mm. (44 \times 5 220.)

Reg	Regions.				Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 11)	:	:	:	:	22631	:	-71909	:	21158	:	.16872	:	-25577
Apex (average of 13	:	:	:	:	18696	:	.77729	:	-23795	:	38185	:	.43623
Bottom (average of 9)	:	:	:	:	.44681	:	-39607	:	.11948	:	.06383	:	.11129
Flat (average of 11)	:	:	:	:	.15132	:	.53564	:	-20354	:	.24505	:	.32138
									.19314	:	.21486	:	-28117
G. A	G. A., 1·54904 mm.	04 mm	. اا	:	.25285	:	-60702	:			.68917		

Case 10.—Cortical measurements in percentage of General Average of Case 1.



excepting the simplest. Is destructive and spiteful, and dirty in her habits. She spits and kicks at the other patients."

Course.—Her intellectual faculties are of a low order. She can neither read nor write much. Can count up to five. Is incapable of proper and distinct articulate speech. Is simple and childish, but very mischievous and restless, and full of monkey-like antics. She is unable to say where she came from. She asks indistinctly for chocolates, and seems quite happy. She cannot do anything for herself in the way of personal supervision. July 24, 1901.—Spends her time running about the ward and playing. She soon became a great favourite and pet with all the asylum officials who came into contact with her. She used to offer flowers to the assistant medical officer, whom she styled her "-eet-eart," and to ask him for chocolates, &c. August 16, 1901.—During the past three days patient has had several convulsions which appear to be of a sub-cortical reflex nature. "Lowest level fits." Her temperature rose to 105°, and she died of exhaustion.

Dura and S.D.—Natural. No excess of fluid. Pia.—Natural. Strips naturally. S.A.—No excess of fluid. Vents. L.—Natural. IV.—A few granulations in the lateral sacs. Vessels.—Natural. The skull-cap is highly asymmetrical, the long diameter extending from the right frontal eminence to the left occipital region. There is no evidence that this has any pathological significance. The brain shows some under-development of the prefrontal region near the mid-line, and this is most evident in the left hemisphere. This is not marked and on ordinary examination the brain would readily pass for normal. Total weight of the encephalon, 1,100 grammes. Cerebellum and pons, 146 grammes. The hemispheres are of exactly equal weight, namely, 477 grammes when unstripped, and 463 grammes when stripped.

Cause of death.—Subacute tuberculous enteritis. Many non-caseous tuberculous glands in the mesentery.

This patient was a much higher ament than the preceding, and during her residence in the asylum was bright, happy, playful, and a great favourite. Both hemispheres were examined micrometrically, and the results give a really remarkable illustration of the extremely close functional relationship between the hemispheres, as the measurements are practically identical, the only difference being that the left pyramidal layer has a slight advantage over the right (see

ł

Fig. 12.

Case 11.—Cortical Measurements in mm. (73 \times 5 = 365). Right Hemisphere.

	Regions.						Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 27)	:	:	:	:	:	:	-28533	:	•78233	:	-20349	:	.13639	:	-22859
Apex (average of 16)	:	:	:	:	:	:	-24765	:	1.05596	:	.30565	:	.38114	:	.47228
Bottom (average of 9)	:	:	:	:	:	:	•39280	:	.32242	:	.08183	:	-05074	:	.07692
Flat (average of 21)	:	:	:	:	:	:	17816	:	-75474	:	-21113	:	-20482	:	.31143
											.20053	:	19327	:	.27231
		G. A	., 1.670	G. A., 1.67095 mm.	11	:	-27598	:	.72886	:			.66611		

Case 11.—Cortical Measurements in percentage of General Average of Case 1.

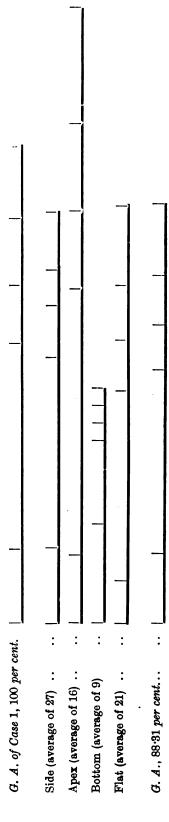
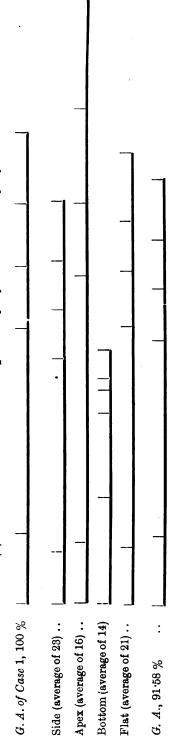


Fig. 13.

Case 11 (A).—Cortical Measurements in mm. (74 imes 5 = 370). Left Hemisphere.

		.67314			:	.77021	:	.28955	:	11	mm.	73290	G. A., 1.73290 mm.	
.27444	:	19941	:	19929										
-28759	:	-20762	:	.20973	:	.88520	:	-24340	:	:	:	:	:	Flat (average of 21)
-09995	:	.05471	:	.09785	:	35036	:	.43033	:	:	:	:	:	Bottom (average of 14)
.46492	:	•37009	:	-29552	:	1.06332	:	-25777	:	:	:	:	:	Apex (average of 16)
.24529	:	16523	:	19405	:	.78197	:	.22671	:	:	:	:	:	Side (average of 23)
Layer V.		Layer IV.		Layer III.		Layer II.		Layer I.					Regions.	
)	.(=) ==		

Case 11 (A).—Cortical Measurements in percentage of General Average of Case 1.



figs. 12 and 13). The measurements, considered as a whole, bear the same relationship to the mental condition of the patient as has been seen in the previous cases.

Case 12.

Admitted November 15, 1895. Died March 28, 1901. Male, aged 37, single. Father and sister insane.

History.—Patient was previously in an asylum for seven months at the age of 26 years. His present symptoms have lasted about nine months. "Says he is going to have a large fortune left to him, and he promises to give me half of it. He says he wrote to the Home Secretary because he fancied that he was watched in Liverpool. He is incoherent."

Course.--Congenitally weak-minded and suffering from mania. Thinks he is wealthy, and is somewhat rambling in his account of himself. Thinks he is in the "wrong box," and that he is not properly certified. Speaks in jerky, incoherent sentences. October 13, 1896.—Believes different languages and shorthand are whispered to him and "sent at him." Thinks one of the nurses wishes to marry him, and writes long and amorous letters to her. October 18, 1897.—Thinks he is mesmerised, and that electricity is "put on him." Somewhat supercilious in manner and very importunate about his discharge. Has aural hallucinations. July 31, 1899.—Is very delusional and suspicious. Says his conduct is guided by a "state concert," and influenced by spirits. Apart from his delusions he looks sensible, talks rationally, and is a hard worker. November 14, 1899.—Is in love with Sarah Bernhardt. Has been upset lately because she acted in Hamlet. November 15, 1900.—Continues to write to people he may think of, giving them his family history and letting them know that he exists. The spirits still influence him. He is developing phthisis. March 28, 1901.—Died of chronic tuberculosis of the lungs.

Dura and S.D.—Natural. Considerable excess of fluid. On the right vertex is a thin reddish film which is readily detachable and of recent date. Pia.—Slight milkiness and slight thickening in the fronto-parietal region. Strips rather more readily than natural. S.A.—Slight excess of fluid. Vents. L.—Very slight dilatation. Choroid cystic. IV.—A few granulations in the lateral sacs. Vessels.—Natural. Total weight of the encephalon, 1,305 grammes; cerebellum and pons, 185 grammes. Right hemisphere, unstripped, 545; left hemisphere, unstripped, 555. Right hemisphere, stripped, 520; left hemisphere, stripped, 527.

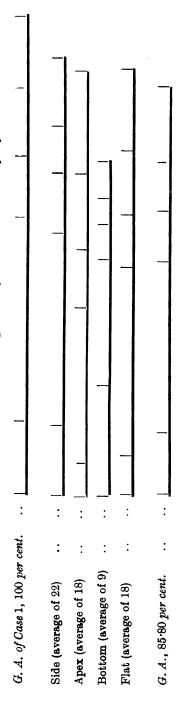
Cause of death.—Chronic tuberculosis of the lungs.

Fig. 14.

Case 12.—Cortical measurements in mm. (67 \times 5 = 335).

Re	Regions				Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Sido (average of 22)	:	:	:	:	.27451	:	.79073	:	-23300	:	.17810	:	-27518
Apex (average of 18)	:	:	:	:	.12030	:	.65385	:	21686	:	.30769	:	.39198
Bottom (average of 9)	:	:	:	:	45008	:	.50246	:	14730	:	.07856	:	•16039
Flat (average of 18)	:	:	:	:	.16203	:	.75041	:	23486	:	-23404	:	.33143
									•30800	:	19960	:	.28975
G. A.,	G. A., 1·62344 mm.	4 mm.	11	:	-25173	:	.67436	:	j		-69735		

Case 12.—Cortical measurements in percentage of General Average of Case 1.



This patient was a high grade ament with a markedly insane heredity. He possessed considerable education, and suffered from semi-systematised delusions with (?) secondary hallucinations, and at the time of his death was in a condition of mild secondary dementia. (Group II. of the first part of this paper). In the table of measurements it will be seen that the two-fold condition of amentia and dementia is associated with a general average depth which is slightly below that of the previous case (see fig. 14).

The present case may be summed up clinically and pathologically as a high grade ament who does not rise to the level of the paranoiac (or very chronic systematised delusional lunatic, who, without additional secondary factors beyond "stress," does not develop dementia). During the "sane" interval between his two incarcerations, his psychic neurones had been subjected to a "stress" beyond their breaking point, and the result was a slowly-progressing mild dementia accompanied by a varying set of semi-systematised delusions with (apparently) secondary hallucinations. The case lies clinically well above the level of Case 11, but the combined non-development and retrogression in a larger cerebrum have given a cortex with a slightly lower general average depth than that existing in the other case.

(d) Insanity with little or no Dementia.

Of the three cases in this group, the first (Group I. of Part I. of this paper; also fig. 6, Plate II.), died of acute dysentery fifteen days after admission, and had had an attack of insanity five years previously from which she recovered. The second (Group II. of the first part of this paper), was of a low and degraded rather than a degenerate type, and died of chronic tuberculosis after a residence of seven years in the asylum. The third (Group II. of the first part of this paper; also fig. 7, Plate II.), had a gross lesion of the right hemisphere of about ten years' standing, which had caused a loss of cerebral substance amounting to at least 80 grammes. She suffered from unilateral fits; was a troublesome patient; and developed little or no dementia during her six years' residence in the asylum.

This patient would probably not have entered an asylum at all, had there not been such a loss of cerebral substance in a brain which originally was not above the average weight. In an exactly similar case (No. 35, Part I.), where the brain was larger but the lesion was almost identical in extent and duration, the patient was twice incarcerated for short periods soon after the occurrence of the lesion, and then for years was able to earn her living, eventually again entering the asylum, in which she died within a few weeks of admission.

Case 13.

Admitted January 9, 1901. Died January 24, 1901. Female, aged 56, married. No family history.

History.—Previously in this asylum at the age of 51 years. During the past few months patient has been reserved and contrary. "Sits with her head bent and eyes cast down and wrings her hands. Has an intensely melancholic appearance, and keeps saying that she has committed a very deadly sin and that this is known all over the town. Will not answer any questions, and is very violent at times."

Course.—Restless, will not answer questions but mutters to herself. Thinks she has committed some deadly sin. Does not take food willingly. Is resistive and poses wherever placed and with the arms in any position. Died of acute dysentery after fifteen days' residence.

Dura and S.D.—Natural, no excess of fluid. Pia.—Natural, strips naturally. Slightly congested and few small extravasations on the middle third of the left hemisphere and over the frontal region of the right. S.A.—No excess of fluid. Vents. L. and IV. and Vessels.—Natural. About the middle of the right ascending parietal convolution is a small patch of very old-standing sclerosis occupying the whole of the width of the gyrus for nearly half an inch. Weight of encephalon, 1,185 grammes. Cerebellum, 165. Right hemisphere, unstripped, 505; left hemisphere, unstripped, 510. Right hemisphere, stripped, 495; left hemisphere, stripped, 500.

Cause of death.—Acute dysentery. (See fig. 6, Plate II.)

Case 14.

Admitted January 20, 1894. Died January 3, 1901. Female, aged 36, married. No family history.

History.—"Sat for some time with her hands clasped and her eyes fixed in front of her obstinately refusing to answer questions. She then suddenly called out 'they haunt me'; asked what, she replied, 'the voices! I came here because they threatened my life.' Will suddenly spring up gesticulating violently and pawing and fighting the air, and screaming the while at the top of her voice. Is being pursued by dogs."

Course.—The patient is of a low and degraded rather than a degenerate type, and her general characteristics are those of the criminal rather than those of the lunatic. Is stupid and resistive and will not converse. Will with difficulty pronounce her name. Makes curious sounds with her mouth. Is very emotional and at times says, "they are on to me." Became restless, noisy, violent and destructive. Was at times slovenly, sat in a heap, and would not employ herself. Finally was heavy, sullen, stupid, and occasionally noisy and destructive, and eventually died of very chronic disseminated tuberculosis of the lungs. The heavy, sullen and stupid condition of the patient, which when she was interfered with culminated in impulsive violence, somewhat resembles the behaviour which would be expected in a eaged beast suffering from chronic disease. It is a mental condition difficult to distinguish from, and often mistaken for, dementia.

Dura and S.D.—Natural, slight excess of fluid. Pia.—Slight fronto-parietal milkiness. Some thickening. Strips readily. S.A.—Slight excess of fluid. Vents. L.—Natural. Vents. IV.—Granulations in the lateral sacs. Vessels.—Natural. Weight of encephalon, 1,235 grammes. Cerebellum, 185 grammes. Right hemisphere, unstripped, 520; left hemisphere, unstripped, 520. Right hemisphere, stripped, 498.

Cause of death.—Chronic disseminated tuberculosis of the lungs and tuberculosis of the ileum.

Case 15.

Admitted April 4, 1894. Died March 15, 1900. Female, aged 49, widow. No heredity of insanity.

History.—Patient has always been of a fretful temperament and has shown symptoms during the past two to three years. These followed a series of fits. "Very dull, melancholic and despondent. Her speech is slow and she seems very distressed in her mind. She has had several fits, and talks very strangely, e.g., she said there was a white rabbit running about the place, that a policeman stood near her and that she was surrounded by

a lot of people. She is very cunning and crafty. Three years ago she had several fits and then became very destructive."

Course.—Mitral systolic murmur. Lungs normal. Partial paralysis of left arm and leg. Sight of left eye bad. Pupils normal. Right grasp good, left feeble. Right knee-jerk normal; left exaggerated. Is melancholic and fancies she saw her husband last week. Says she has slept badly and has had bad dreams. Memory and ideation good. Is quiet and gives no trouble, but is frightened and timid. Says she has fits once in Cannot look after herself. June 2, 1894.—Is two months. better but unstable. June 5, 1895.—Is depressed and constantly Has about a fit a month. January 10, 1896.—Is troublesome and abusive and upsets the other patients. October 4, 1896.—Has delusions of persecution by her friends and is very depressed. June 25, 1899.—Had a short series of fits this month. Has been as long as five months without a fit, and has had from one to twenty-five in a month. Her mental condition is unchanged. At times she is quiet and no trouble and at other times she is depressed or unstable and abusive. March 15, 1900. -Last night she had a succession of ten convulsions, chiefly affecting the left or paralysed side. There was no real intermission between them, the arm being slightly affected during the whole time. They stopped after an enema. A few hours later she suddenly collapsed. She revived after strychnine, but later on had another fit. She improved after a while and took her food and talked. Later she had a discharge of blood-stained mucus from the rectum, and collapsed and died this morning.

Dura and S.D.—Natural, no excess of fluid. Pia.—Very slight thickening of the left pia which strips rather more readily than natural. No S.A. excess on this side. In the right hemisphere there is a large old-standing softening affecting the lower part of the motor area, the supra-marginal gyrus, and nearly the whole of the outer surface of the temporo-sphenoidal lobe. In the region of the lesion there is considerable S.A. excess. The cause was probably embolic occlusion of the middle cerebral artery. Vents. L.—Right somewhat dilated. Left natural. Vents. IV. and Vessels.—Natural. Weight of encephalon, 1,155 grammes. Cerebellum, 160 grammes. Right hemisphere, unstripped, 423; left hemisphere, unstripped, 505. Left hemisphere, stripped, 488.

Cause of death.—Status epilepticus. Old-standing morbus cordis. (See fig. 7, Plate II.).

The intracranial contents in Case 13 were to the naked eye absolutely normal, and as will be seen in the fig. 15, in

Fig. 15.

Case 13.—Cortical Measurements in mm. (71 \times 5 = 355).

		.73054			:	69001.	:	.26129	:	11	G. A., 1.69252 mm.	, 1.692	G. A.
•30207	:	-21630	:	-21217									
.34826	:	.26198	:	.23989	:	-75334	:	-20622	:	:	:	:	Flat (average of 14)
.15221	:	.08347	:	.14894	:	.49100	:	.46645	:	:	:	:	Bottom (average of 9)
•43306	:	•35706	:	.24275	:	-81486	:	.15732	:	:	•	:	Apex (average of 25)
-27475	:	.16267	:	-21711	:	.74355	:	-21518	:	:	:	:	Side (average of 23)
Layer V.		Layer IV.		Layer III.		Layer II.		Layer I.				Regions.	œ
				•									

Case 13.—Cortical Measurements in percentage of General Average of Case 1.

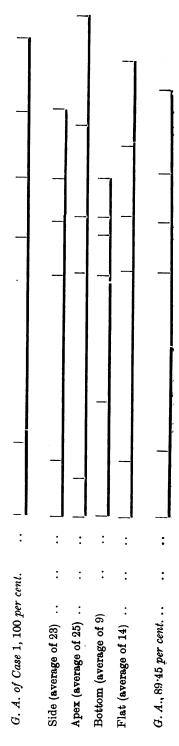


Fig. 16.

Case 14.—Cortical measurements in mm. (70 \times 5 = 350).

Regions	ons.				Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 23)	:	:	:	:	-25297	:	.77108	:	.24080	:	.18637	:	.27859
Apex (average of 24)	:	:	:	:	.16571	:	·83040	:	-25778	:	•36641	:	•43883
Bottom (average of 9)	:	:	:	:	.43535	:	. 45336	:	$\cdot 13912$:	.07529	:	.14403
Flat (average of 14)	:	:	:	. :	•20096	:	96166	:	.28513	:	.28829	:	.37246
									•23071	:	•22909	:	.30848
G. A.,	G. A., 1.78615 mm.	15 mm	11	:	.26375	:	.75412	:			.76828		

Case 14.—Cortical measurements in percentage of General Average of Case 1.

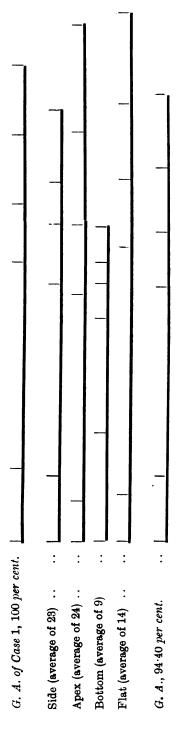


Fig. 17

Case 15.—Cortical measurements in mm. (64 \times 5 = 320).

-21727	.44994	13573	36761	-29264	
:	:	:	:	:	
14546	-34415	.07786	.26834	.20895	-71341
:	:	:	:	:	
.20622	.25577	$\cdot 13362$.25169	.21182	
:	·:	:	:		:
.71809	.86371	.49556	·81527		.72316
:	:	:	:		:
-24765	.17542	.44190	.17292		.25947
:	:	:	:		:
:	:	:	:		n. =
:	:	:	:		604 mi
:	:	:	:		G. A., 1·69604 mm.
side (average of 16)	pex (average of 11)	Sottom (average of 14)	Plat (average of 23)		G. A
	•71809 •20622 •14546				14546 24765 71809 20622 14546 34415

Case 15.—Cortical measurements in percentage of General Average of Case 1.

G. A. of Case 1, 100 per cent.	cent.		_			-1
Side (average of 16)	i		_			
Apex (average of 11)	:	_			_	
Bottom (average of 14)	_	_				
Flat (average of 23)	:		-	-		-,
G. A., 89.64 per cent.					-	

general detail the measurements much resemble those of Case 1 (normal brain). There is, however, throughout the measurements contained in the table a great diminution (over 15 per cent.) in the depth of the pyramidal layer of nerve-cells. This puts the case into the category of amentia or cortical under-development. Case 15 is almost the counterpart of this in every detail. Case 14, on the other hand, is better developed and comes within 1.5 per cent. of the lowest normal (Case 3). (Figs. 15-17.)

A comparison of these results with the clinical histories, in view of the conclusions drawn in Part I. of this paper, and especially when the results of the examination of the cases of marked dementia to be described shortly are compared with them, shows that in insanity without dementia a gross lesion exists, which is of the same nature as, and only differs in degree from, that existing in the cases usually classed as "amentia." This lesion is not of any peculiar nature, but consists in an arrest of cortical development at some stage of this process. This may be seen by reference to the section which deals with normal amentia (pp. 571-8), and to the section on the normal adult cortex (pp. 565-570), in which it is shown that the differences existing between different normal brains concern the pyramidal layer of the cortex alone.

The whole investigation shows that the mental power of the individual bears a definite relationship to the depth of the pyramidal layer of nerve-cells in the prefrontal cortex. Whether this is true for other regions of the cortex also, or chiefly concerns the prefrontal region, may be settled by further investigation. It is, however, à priori probable that differences occurring elsewhere in the mantle of the cerebrum are concerned less with general coordinate mentation than with the special functional characteristics of these parts. They will probably be found to serve as a basis for the special type of insanity from which the patient, if insane, suffers; and in normal persons, in whom such differences may be almost or quite inappreciable to the micrometric method, for the special mental characteristics of the individual.

Dementia.

Under this heading are described two cases of insanity with more or less severe dementia, two cases of gross dementia in which all symptoms of insanity had died out, and one case of gross dementia paralytica.

(e) Cases of Insanity with Severe Dementia.

Case 16.

Admitted April 18, 1900. Died February 8, 1901. Female, aged 59, married. Aunt insane.

History.—Symptoms began at the age of 48, and have continued every since. "Delusion that her husband was with her last night. Does not know year, month or season. Talks continually to imaginary people. At times is lost in her mind, not knowing what she is doing. Has been strange for the past ten years. Is always talking to imaginary people, and thinks that she sees people who have been dead for years. At times is quite violent, and throws things about." (Note the severe mental confusion.)

Course.—Gives a very rambling and confused account of her past life. Memory defective. Auditory hallucinations. Was very noisy last night, as she wanted to cook a steak for her husband, who she thought was in the asylum. Takes her clothes off. Looks older than her reputed age. April 20, 1900.—Restless and noisy occasionally. June 6, 1900.—Incoherent in conversation. Memory defective. August 9, 1900.—Still destructive and noisy. Memory impaired. February 8, 1901.—Patient changed very little till her death, which occurred from recent tuberculosis of the lungs.

Dura and S.D.—Thickened and adherent to the skull-cap in the frontal region. Considerable excess of fluid. A membrane, in parts rusty and in parts red in colour and the thickness of brown paper, lies over the right vault, the whole of the right base above the tentorium, and also, but to a less extent, in the left anterior and middle fossæ. The membrane is thickest at the vertex, and thinnest at the base. Both on the right vault and at the right side and base are several recent extravasations between the membrane and the dura. The membrane is not adherent to the pia, and readily strips from the dura. Pia.—The pia over the right hemisphere is stained brown at the vault. It is not opaque, but is thickened, chiefly in the fronto-parietal region. It strips readily, except in the occipital and lower temporo-sphenoidal regions. S.A.—Excess of fluid. Vents. L.—Slightly dilated.

IV.—Small granulations in the lateral sacs. Vessels.—Considerable dilatation of the basal arteries and a few calcareous patches in the cortical branches. The brain shows marked prefrontal, moderate fronto-parietal and first temporal wasting, and little or no wasting elsewhere. The left hemisphere is slightly more affected than the right. Weight of encephalon, 1,220 grammes. Cerebellum, 135 grammes. Right hemisphere, unstripped, 535; left hemisphere, unstripped, 525. Right hemisphere, stripped, 515; left hemisphere, stripped, 503.

Cause of death.—Recent tuberculosis of the lungs. (See fig 8, Plate II.)

Case 17.

Admitted February 2, 1900. Died March 10, 1900. Female, aged 53, married. Half-sister insane.

History.—Previous attack at the age of 48. Epileptic. Both the patient and her family are intemperate. "Has a delusion that she knows the magistrate quite well, and that she has been in this house for six years, and that a doctor gave her £13,000, and that her husband is building her a home with the money. Very rambling in her talk. Is so noisy that she has to be kept in the padded room; is rambling and incoherent, and fancies that she knows everybody. Husband says that she wanders in her conversation, and was for two days driving about in cabs and buying unnecessary things, owing to the delusion that she was going to make a lot of money." (Note the severe mental confusion.)

Course.—No idea of time, and only for a few moments conscious of her surroundings, her attention being taken up with visual and auditory hallucinations. Says she has £13,000 and a beautiful black silk dress covered with beads, but at the same time wants to pawn everything she has. Is rambling, incoherent, restless, and talkative, and sleepless at night. February 23, 1900.—Is restless and mischievous, and constantly muttering, looking for snakes, and unfastening her clothes. March 1, 1900.—Very tremulous, but has had no distinct convulsion. March 10, 1900.—Has gradually become weaker, and has had frequent twitchings of the muscles of the face and other parts of the body on both sides. Died of chronic tuberculosis of the lungs without recovering from the acute mental symptoms which were the cause of her re-admission.

Dura and S.D.—Slight adhesions to the skull-cap in the frontal region. Excess of fluid. Pia.—No opacity. Considerable thickening and ædema in the fronto-parietal region. Strips

like a glove. S.A.—Considerable excess of fluid. Vents. L.—Natural. IV.—A few slight granulations in the lateral sacs. Vessels.—A little basal atheroma. The brain shows very marked wasting in front of the ascending frontal gyrus and moderate wasting of the rest of the fronto-parietal region and the first temporal gyrus. There is relatively little in the rest of the brain. Weight of the encephalon, 1,112 grammes. Cerebellum, 145 grammes. Right hemisphere, unstripped, 460; left hemisphere, unstripped, 470. Right hemisphere, stripped, 435; left hemisphere, stripped, 445.

Cause of death.—Chronic tuberculosis of the lungs. (See fig. 9, Plate II.)

In both these cases there were well-marked morbid appearances inside the skull-cap. The encephalon of the former (see fig. 8, Plate II.) was more than 100 grammes heavier than that of the latter (see fig. 9, Plate II.). The former was only ten months in the asylum, but had been more or less insane for years. The latter was only five weeks in the asylum, but had had a previous attack five years before, from which it is probable that she did not really recover. She also suffered from convulsions. Both cases on admission exhibited considerable mental confusion, and both showed degeneration of the cerebral vessels at the post-mortem examination.

The results in the tables are very similar to one another, and show marked diminution in the depth of the cortical layers, especially the pyramidal. The morbid changes in the intracranial contents, especially the excess of fluid, show that the diminution of the brain is largely due to wasting, in this differing from the non-development in the last set of cases (see figs. 18 and 19).

(f) Cases of GrossDementia.

Case 18.

Admitted July 21, 1894. Died April 1, 1901. Female, aged 78 years, married. No family history.

History.—In an asylum about 1874, at the age of 52. "Subject to delusions of a depressing character. Thinks she is to be executed. Hears men's voices talking about her. Says she is to

Fig. 18.

Case 16.—Cortical measurements in mm. (56 \times 5 - 280).

		.70321			:	.69822	:	.24785	:		928 mn	G. A., 1·64928 mm.	G. A
-29237	:	.20840	:	20244									
.35025	;	.26841	:	.22259	:	-74959	•	.17021	:	:	:	;	Flat (average of 9)
.14116	:	.07242	:	$\cdot 14362$:	.51432	:	-43822	:	:	:	•	Bottom (average of 12)
.42110	:	32665	;	-22095	:	.71311	:	$\cdot 16203$:	:	:	:	Apex (average of 17)
-25696	:	.16612	:	-22259	:	·81588	:	-22095	:	:	:	:	Side (average of 18)
Layer V.		Layer IV.		Layer III.		Layer II.		Layer I.				egions.	Reg

Case 16.— Cortical measurements in percentage of General Average of Case 1.

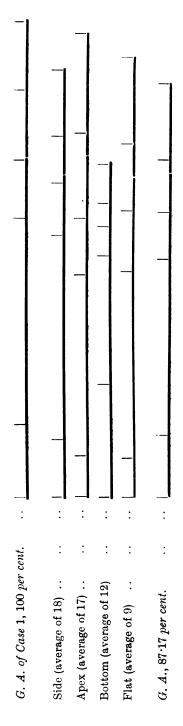
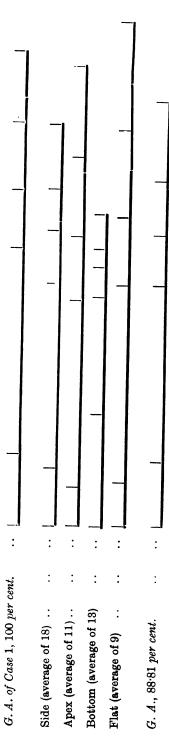


Fig. 19.

Case 17.—Cortical measurements in mm. (51 imes 5 = 255).

Layer V.	.24632	.37769	19691	76067	29328	
	:	:			: :	
Layer IV.	.16858	.31469	.06345	.35188	.22465	-73632
	:	. :	:	:	:	
Layer III.	-22341	.23836	.13030	.28151	.21839)
	:	:	:	:		:
Layer II.	.73895	.75123	.47589	.78069		69989.
ns. Layer I.	•	:	:	:		:
	.23486	16069	.45550	.17840		.25736
	:	:	:	:		:
	:	:	:	:		n.
	:	:	:	:		037 mm.
	:	:	:	:		i. A., 1·68037
Regions	Side (average of 18)	Apex (average of 11)	Bottom (average of 13)	Flat (average of 9)		G. A

Case 17.—Cortical measurements in percentage of General Average of Case 1.



have her head cut off. Thinks people follow her. Last night someone tried to burn her. Wishes to be sent to prison or decapitated."

Course.—Has hallucinations of hearing, and says that the voices say wicked things about her. Is confused, and her memory is bad. Sits about all day and takes no interest in her sur-Habits correct. June 19, 1895.—Rambling in conversation. Memory impaired. Helpless. June 20, 1896.— Dull, uninterested in her surroundings and unoccupied. Memory very defective. Cannot answer the simplest questions. June 22, 1898.—Cannot remember people she sees daily. Very feeble. Blind in the right eye. March 7, 1899.—More feeble. Has a delusion that her bowels are not opened. January 17, 1900.—Is always asking for medicine. April 18, 1900.—Is very feeble and fidgety, but up and able to be out of doors. March 31, 1901.— Became gradually more feeble and grossly demented, and died of bronchitis.

Dura and S.D.—Natural. Great excess of fluid. Pia.— Opaque and thickened. Strips very readily. S.A.—Very great excess of fluid. Vents. L.—Considerably dilated. IV.—Natural. Vessels.-Much atheroma of the circle of Willis, especially the basilar artery. The brain shows very marked wasting of the prefrontal region, well-marked wasting of the fronto-parietal and first temporal convolutions, and a less marked condition elsewhere. The wasting in the left hemisphere is more marked and more general than in the right. Weight of the encephalon, 1,175 grammes. Cerebellum, 165 grammes. Right hemisphere, unstripped, 485; left hemisphere, unstripped, 480. Right hemisphere, stripped, 450; left hemisphere, stripped, 440.

Cause of death.—Bronchitis.

Case 19.

Admitted April 7, 1894. Died February 1, 1901. Female, aged 53 years, married. No family history.

History.—" Suffering from partial paralysis of the brain. Is inclined to be violent, and is constantly muttering to herself. States that 'she is pregnant, but not by her husband.'"

Course.—Choreiform movements of the head and face, and paralysis of the right side of the mouth. Rolls herself about. Reflexes increased. Pupils normal. Is heavy, stupid, and unable to answer the simplest question. Is restless and fidgety, and thinks she is to be confined in a day or two. Is most incoherent. October 20, 1895.—Is weak-minded and childish, and shows

marked choreiform movements when speaking, or when she is taken notice of. November 7, 1896.—Childish and strange in manner, but clean, tidy, and industrious. January 25, 1897.—Is depressed, and has threatened to injure herself. April 25, 1897.— Brighter and more cheerful, but very demented. Helps a little. July 3, 1898.—Still helping a little in the ward. April 3, 1899.— Feeble, grossly demented. Wet and dirty. March 12, 1900.— Knee-jerks much increased. Right pupil 3, left 2½ mm., accommodate to 2½ and 2. No reaction to light. When addressed she gets excited, and talks in a lively and rather superior manner, but she is incoherent, wet and dirty, destructive, ravenous, and unable to dress herself. She can still, however, state her age and the occupation of her husband, &c. June 7, 1900.—Right pupil 3½, left 3 mm., accommodate to 3 and 2½ mm., and inactive to light. October 11, 1900.—Left knee-jerk now preponderates over right, but both are much increased. Right pupil $4\frac{1}{2}$, left 4 mm. Accommodate first to 3 and $2\frac{1}{2}$ mm., then by straining to $2\frac{1}{2}$ and 2 mm. Inactive to light. November 21, 1900.—Pupils irregular. Grinds teeth and is a repulsive object. Makes faces and strikes absurd attitudes. Large choreiform, non-rhythmic movements of arms. January 31, 1901.—Right pupil 1 + mm., left 1 mm., and inactive. Left arm appears weak. Can pronounce labials but not gutterals. Is now exceedingly emaciated and so changed in appearance that she cannot be recognised. February 1, 1901.—Died of subdural hæmorrhage.

Dura and S.D.—Slightly thickened on the left side. Enormous excess of blood-stained fluid. Over the whole of the vertex on both sides, but thicker on the left, is a membrane which remains on the hemisphere on the right side, and on the dura on the left. On the right side a hæmorrhage consisting of about 1 oz. of recent blood-clot has occurred between the membrane and the pia, and on the left side smaller hæmorrhages exist between the membrane and the dura. Films exist on the base above the tentorium, and in the anterior fossæ at least three layers Pia.—Opaque, except in the temporo-sphenoidal region and at the posterior pole. Much thickened, and strips very readily. S.A.—Enormous excess of fluid. Vents. L.—Dilated. IV.—Granulations in the lateral sacs. Vessels.—Apparently natural. The brain shows wasting, which is most extreme in the prefrontal region, marked in the fronto-parietal and first temporal convolutions, and moderate in the rest of the brain. Weight of encephalon, 1,025 grammes. Cerebellum, 165. Right hemisphere, unstripped, 415; left hemisphere, unstripped, 390. Right hemisphere, stripped, 355; left hemisphere, stripped, 347.

Cause of death.—Subdural hæmorrhage (see fig. 10, Plate III.).

Note.—The systematic record of the pupils may be usefully compared with the abnormal condition of the subdural space and the neighbouring regions.

There being no complete history of these cases, it is impossible to be certain as to the actual amount of underdevelopment in each brain, but there is no doubt that in both cases it is quite overshadowed by the amount of The fact, however, that Case 18 was insane twenty years previously, and that, in spite of her advanced age and of the naked-eye atheroma present, the degree of wasting is less marked than in Case 19 (see fig. 10, Plate III.), suggest that in the former case a greater degree of under-development existed than in the latter. This is also probable owing to the decreased depth of the superficial layer of the cortex in Case 18, in which there is less neuroglial proliferation than in Case 19. Allowing for all the possible fallacies which may occur during the measurement of the superficial layer of the cortex, the fact remains, this layer is distinctly below the normal depth in all the quoted cases, except one high grade imbecile (Case 11), until the two most extreme dements are reached, namely, Cases 19 and 20, both of which show a marked amount of chronic neuroglial proliferation, and only the latter of which was a case of dementia paralytica (see pp. 485-7).

Both the cases under consideration exhibited marked mental confusion, and both finally developed gross dementia and showed very marked morbid changes inside the skull-cap. This is well seen in the tables of measurements, especially those of Case 19, where both extreme narrowing of the pyramidal layer and considerable narrowing of the other layers is shown. Case 19, in fact, the outside layer and its associated superficial neuroglial proliferation being excluded, is practically identical in measurements, as was the patient in her mental condition, with Cases 7 and 8, a full-term female feetus and a six weeks' child respectively. This fact will be referred to in the summary at the end of the present section (see figs. 20 and 21).

Fig. 20.

Case 18.—Cortical measurements in mm. $(80 \times 5 = 400)$.

Layer V.	.22924	.36518	.12152	.30442	-25509	
	:	:	:	:	:	
Layer IV.	15835	.32590	.06628	-23568	19655	.66457
	:	:	:	:	:	
Layer III.	-22878	.23507	.13380	.25409	.21293	
	:	:	:	:		:
Layer II.	.75767	.74325	.44436	-80524		.68763
	:	:	:	•		:
Layer I.	21911	.14730	•40876	.17799		-53829
	:	:	:	:		:
	:	:	:	:		п :
	:	:	:	:		049 mn
ions.	:	:	:	:	•	G. A., 1·59049 mm.
Regi	:	:	f 12)	:		G. A
	Side (average of 32)	Apex (average of 24)	Bottom (average of	Flat (average of 12)		

Case 18.—Cortical measurements in percentage of General Average of Case 1.

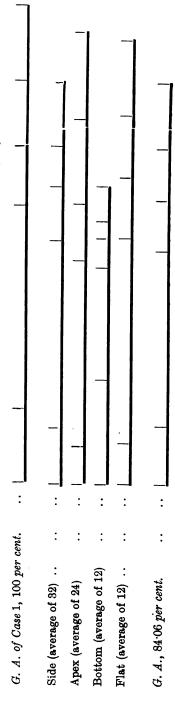
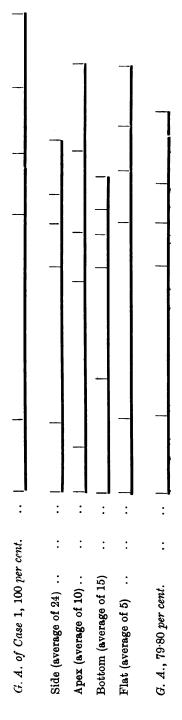


Fig. 21.

Case 19.—Cortical measurements in mm. $(54 \times 5 = 270)$.

Reg	Regions.				Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 24)	:	:	:	:	.27803	:	.61989	:	18413	:	.13193	:	.19149
Apex (average of 10)	:	:	:	:	17087	:	.65990	:	.20180	:	.31670	:	-33437
Bottom (average of 15)	:	:	:	:	.45663	:	.45565	:	.13257	:	.09231	:	.13748
Flat (average of 5)	:	:	:	:	-28282	:	.78953	:	20917	:	15614	:	-23863
									18192	:	17427	:	.22549
Ð	. A., 1·51001 mm.	001 mm	 	:	-29709	:	-63124	:			•58168		

Case 19.—Cortical measurements in percentage of General Average of Case 1.



Gross Dementia Paralytica.

Case 20.

Admitted November 10, 1899. Died January 1, 1901. Male, aged 41 years, married. Clerk. Uncle insane. Mother died of phthisis. Family intemperate.

History.—Married six years. No children. Informed his wife that he had a serious attack of syphilis in early life. Until Christmas, 1898, patient was healthy mentally and physically. Has been temperate, at any rate since marriage. During his attack of syphilis patient says that "he took enough mercury to kill a horse." Shortly before Christmas, 1898, patient had a series of fits, and was unconscious after the first for twenty-four hours. He had forty-two in four days, and has had fifty or more during the present year. Has been in two asylums, with an interval of two weeks at home, since the fits began. "Demented. Cannot reply to simple questions correctly. Memory quite lost. Physical signs of G. P. I."

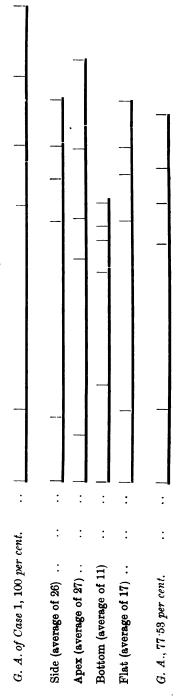
Course.—Slight hypospadias. Old scar on left side of glans penis. Pupils about 3½ mm., but they vary, and the right is usually larger than the left. React sluggishly to light. Knee-jerks exaggerated. Strongly resists examination as if afraid of being hurt. Does not speak a word. Sleeps badly and is wet, and occasionally dirty in his habits. During the next month or two he occasionally spoke a word or two, and frequently smiled. Has not conversed with his wife since some fits a month before admission. December 20, 1899.—Auditory and visual hallucinations. Restless. Has sworn more to-day than he has used words since admission. February 27, 1900.—At times takes up a book, but as he never speaks it is impossible to tell whether he understands what he reads. April 24, 1900.—Several right-sided con-June 5, 1900.—A long series of mixed convulsions, which lasted in a mild form for three weeks. July 24, 1900.— Helpless and resistive. Right knee-jerk much increased; left knee-jerk increased. Right pupil 6 mm., left 5 mm. Accommodate to 4 mm. and 3 mm. No reaction to light. Right pupil irregular. August 18, 1900.—More feeble and rapidly losing flesh. Becomes more and more resistive. October 25, 1900.—Resistive, but otherwise inanimate except for occasional "monkey-tricks." Right pupil 4½ mm., left 3½ mm. Accommodate to 3 + and 21 mm. No reaction to light. Became still feebler, and died slowly of broncho-pneumonia.

Fig. 22.

Case 20.—Cortical measurements in mm. $(81 \times 5 = 405)$.

Reg	Regions.				Layer I.		Layer II.		Layer III.		Layer IV.		Layer V.
Side (average of 26)	:	:	:	:	-25494	:	.79372	•	.17903	:	.12974	:	.17846
Apex (average of 27)	:	:	:	:	18767	:	-69504	:	19094	:	-26787	:	-34097
Bottom (average of 11)	:	:	:	:	.37896	:	.45663	:	.12186	:	.05758	:	.10177
Flat (average of 17)	:	:	:	:	27640	:	.78416	:	.17849	:	.11264	:	.18109
									16758	:	.14196	:	20057
Ð	G. A., 1·46699 mm. =	ш 6699	m. =	:	.27449	:	68239	:			.51011		

Case 20.—Cortical measurements in percentage of General Average of Case 1.



Dura and S.D.—Natural. Great excess of fluid. A small quantity of lymph between pons and occipital bone. Pia.— Marked fronto-parietal opacity and thickening. Extreme mid-line prefrontal adhesions. Both on the median surface in the prefrontal region, to some extent in the prefrontal region externally, and also in the post-central region and the whole of the temporosphenoidal lobe there is marked decortication. In the remainder of the fronto-parietal region the pia-arachnoid is ballooned out with fluid, and strips like a glove from the brain (see photo., fig. 11). S.A.—Great excess of fluid. Vents. L.—Considerably dilated. Many scattered granulations. IV.—Granular throughout. Vessels.—Apparently natural. The brain after hardening in formalin cuts like soft wood. The wasting is very extreme in the prefrontal region, it is marked in the central convolutions, it is marked and the disease is acute in the parietal region and the whole of the temporo-sphenoidal, and it is moderate in the rest of the brain. Weight of encephalon, 1,280 grammes. Cerebellum, 198 grammes. Right hemisphere, unstripped, 535; left hemisphere, unstripped, 527; left hemisphere, partially stripped, 475.

Cause of death.—Broncho-pneumonia and dementia paralytica (see fig. 11, Plate III.).

The last of the twenty cases (see fig. 11, Plate III.) is one of gross dementia paralytica, the subject of which was practically an inanimate object for some months prior to his death.

The table of measurements shows even more marked wasting than that in Case 19, but this is more obscured here than in that case by the large amount of neuroglial proliferation which is present both in the superficial and the pyramidal layers (fig. 22). More need not be said concerning this case than that it strikingly supports the conclusions concerning the etiology of dementia paralytica which were advanced in the first part of the present paper.

CONCLUDING SECTION AND SUMMARY OF PART II.

THE FUNCTIONS OF THE PRIMARY CELL LAYERS OF THE CORTEX CERBBRI.

This summary should be read in conjunction with the tables (figs. 23 and 24) inserted immediately after it, which collate the results obtained from the twenty cases examined

into percentages, and also show them graphically. Case 1, the first normal, is used as the basis for the percentages, as it is almost exactly equal to the average of the three normal cases. The microphotographs on fig. 18, Plate VI., should also be noted in this connection.

The primary afferent and lower associational areas of the cerebral cortex have been referred to in a previous communication, and the present research is a continuation of the same subject.

The normal prefrontal cerebral cortex.—In the three normal cases examined, not one of which is likely to be developed above the average, and any one or all of which may be below this, the general average measurements of the first case are almost the counterpart of the average of the three. The difference between the several cases exists in the pyramidal layer of cells, which of all the layers is the easiest to measure accurately, and the other layers are practically of the same depth.

The development of the prefrontal cerebral cortex.—The prefrontal cortex begins to laminate about the sixth month of fœtal life by the separation off of the polymorphic layer (V.) and the inner line of Baillarger (IV.), both of which layers are very little below (three-fourths of) the normal depth almost from the first. The layer of granules (III.) next develops, and at the period referred to is only about half the normal depth. At this time the pyramidal layer (II.) is only one-fourth of the normal depth. At birth the pyramidal layer is still little more than half the normal depth; the granule layer (III.) has now become three-fourths of the normal, and the fourth and fifth layers are as before (rather more than three-fourths of the normal depth).

The prefrontal cortex of congenital amentia.—Degrees of under-development, general and local, exist, which vary inversely with the mental power of the individual concerned.

The prefrontal cortex of chronic insanity without dementia.—In these cases under-development of the pyramidal layer of nerve-cells exists, the other layers being approximately normal.

The prefrontal cortex in dementia and dementia para-

lytica.—Degrees of wasting exist which vary directly with the amount of dementia present. When the mental power of the patient is that of the new-born child, all the cortical layers are approximately in the same condition as in the latter. This is seen in the following table:—

Туре.	I. Superfl.	II. Pyraml.	III. Grans.	IV. Baillar.	V. Polymor.
Normal = 100 per cent. (Case 1.)	15 per cent.	44 per cent.	13 per cent.	12 per cent.	16 per cent.
Stillborns = 66.8 per cent. (Cases 7 and 8.)	10.7 per cent.	26.6 per cent.	8.7 per cent.	8.8 per cent.	12 per cent.
Gross dementia = 78.4 per cent. (Cases 19 and 20.)	15 per cent.	34.7 per cent.	9·2 per cent.	8·3 per cent.	11.2 per cent.

Allowing here for neuroglial and vascular proliferation in the two external layers, these two series show a marked resemblance to one another, as do the corresponding mental conditions; and as a child under the age of a few months is still relatively helpless and mindless, an even closer parallel of measurements might be made than the above. The two sets of percentages given, however, representing as they do the condition of the cortex at birth, when mentation is about to begin, and at death in a condition of brain atrophy, with the mind practically completely gone, are sufficiently striking.

Amentia and dementia.—In many cases amentia undoubtedly co-exists with dementia, but as a whole the greater the amentia the less is the dementia co-existing, and vice versâ; as the less highly developed the neurones the greater is their relative durability, and the less is the injury produced by the slight "stress" which is necessary to affect them, whilst, on the contrary, highly developed but deficiently durable neurones, to be subjected to a breaking strain by "stress," require it in their case to be so great that rapid degeneration results. This degeneration only becomes extreme in those cases in which severe vascular affection is present.

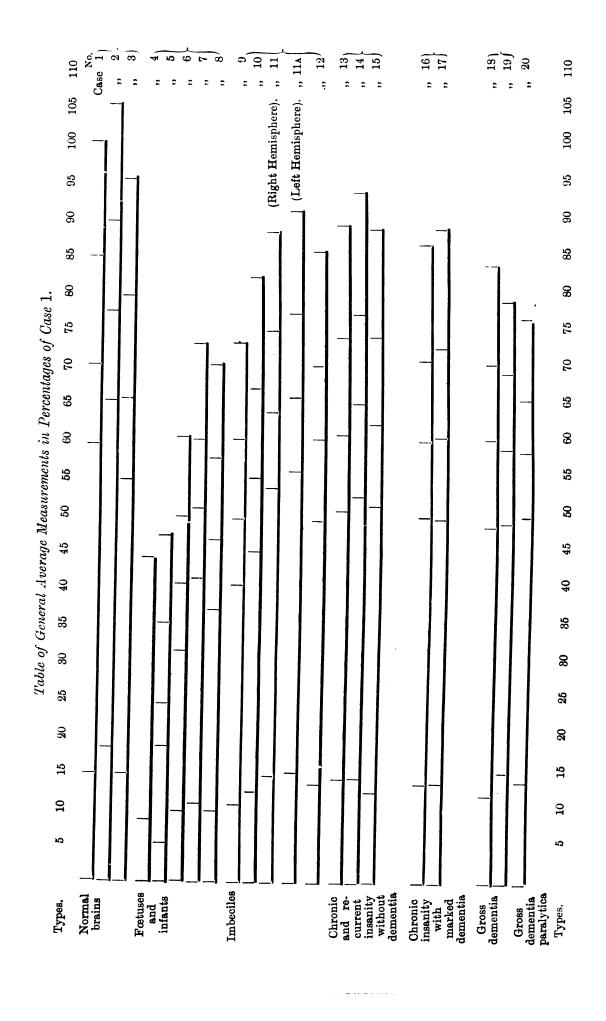


Fig. 24.

General Average Measurements in Percentages of Case 1.

Case.	Gı	roup.		Type.		C.		Py.		Gr.	В.		P.		Total.
1	• •	—	••	Normal.	• •	14.64	••	44.20	••	12.75	12.47	••	15.94	••	100.00
2		_	••	Normal.	••	18 ·05		47.64	••	11.60	41.16		16.40	••	105·4 6
3		_	• •	Normal.		14 •96	••	39:95	••	11.93		••	16 ·78	••	95.90
4	• • •			Fœtus,		8.17				— 35·	40·99 81 —				43.98
5	••		••	4 months. Fœtus, 6 months.	••	6.23	••	11.68	••	6.23			11.68		47 :50
6		_	••	Stillborn (male).		9.94	••	22.94	••	8.14		••	11:32		60:21
7	••		••	Stillborn (female).	• •	11.44	••	30.42	••	9.41		• •	12.67		7 3·65
8	••	_	••	Infant, aged 6 weeks.	••	9.92		27:49	••	9.20	31·79 10·15		13.41		70:17
9	••	I.	••	Imbecile.		11.03	••	29.72		8.61	32·76 10·00		13·58		72 ·94
10	••	I.		Imbecile.		13.36	••	32.08		10.21	32·19 11·36		14.86		81.87
11		I.	••	Imbecile.	••	14.59	••	38.52		10.60	36·48 10·21		14.39		88:31
11 (A	٠)	I.	••	Imbecile.		15.30		40.71		10.53	35·20 . 10·54		14.50	٠.	91.58
12	••	II.		Imbecile, with mild dementia.	••	13:31		35.64		10.99	35·57 10·55		15:31		85:80
13		I.		Recurrent insanity, without dementia.	••	13.81	••	37.03	• •	11.21 .	36·85 . 11·43		15.97		89 ·45
14		II.	••	Chronic insanity, without dementia.	••	13.94	••	39.86		12:19 .		•••	16:30	• • •	94:40
15	••	11.	••	Chronic insanity, without dementia.	••	13.72	••	38.22		11.19 .	40.60		15.47		89:64
16	••	III.		Mania, with marked dementia.		13·10		36.90	٠.	10.70	37·70 11·02	-	15.45		87:17
17	•••	IV.		Marked dementia.		13.60	٠	36.29	٠	11.55 .	37·17 . 11·87 ——~-		15·50 	٠	88:81
18		V.		Gross dementia.		12.60		36:34		11.25 .	38·92 . 10·39		13·48 	٠.	84 06
19	••	V.		Gross dementia.		15.70	٠	33.36	·	9.61 .	85·12 . 9·21		11.92	١	. 79.81
20	• •	_		Gross dementia paralytica.		14.50	٠.	36.07	• ••	. 8.86 .	 ~-) —	10.60		. 77: 53
											26.96	3			

General.—Functions of the Cortical Cell Layers.

The layer of polymorphic cells (V.) is the first to be differentiated during the process of lamination, and it is the last to fail in the retrogression of dementia. A decrease in this layer exists in extreme aments (normal or otherwise), and in dements who are unable to carry on the ordinary animal functions, such as attending to their own wants, &c., &c. This layer, therefore, probably subserves these lower voluntary functions of the animal economy.

The granule layer (III.) is developed after the polymorphic layer. In the primary visual area the optic radiations end in the midst of the hypertrophied and duplicated granule layer. This layer, therefore, probably, reasoning by analogy, subserves the reception or immediate transformation of afferent impressions, whether from the sense organs or from other parts of the cerebrum.

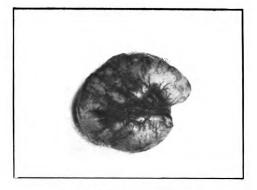
The pyramidal layer (II.) is the last layer of the cortex cerebri to develop, and it is also the first to undergo retrogression in dementia. It is the only layer which appreciably varies in depth in normal brains; the degree of its development in normal infants and in congenital aments varies directly with the mental power of the individual, and the degree of its retrogression in demented patients varies directly with the amount of dementia existing in the patient. This layer, therefore, subserves the "psychic" or associational functions of the cerebrum.

The first and fourth layers of the cortex cerebri, being primarily cell-process layers, do not need further reference in this connection, although it is not denied that the relatively small number of cells which, in the adult state of the cortex especially, are contained in these layers, may and probably do possess important though minor functions in the processes of cerebration. In the sensori-motor area, for example, the Betz cells, which really belong in the opinion of the writer to the fourth layer or "inner line of Baillarger," and are therefore not "pyramidal" cells at all, constitute the important efferent tract for skilled voluntary movement. Probably the "solitary cells" of Meynert in the occipital cortex possess a somewhat analogous function, and perhaps the same may be

said concerning the more or less pyramidal-shaped cells which lie in Layer IV., or the "inner line of Baillarger," in other regions of the cerebrum. One is probably hardly justified in assigning a function to the few cells which lie in the first or superficial layer of the cortex cerebri, but perhaps, reasoning on general grounds, it is not unfair to suggest that they possess associational functions similar to those of the pyramidal layer above which they lie, and with which, in order of time, they appear to be developed.

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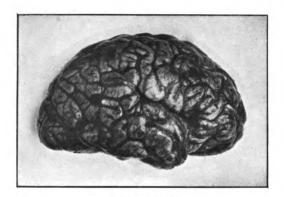
PLATE I.



Four months' feetus. Fig. 1.



Six months' fœtus. Fig. 2.



Male stillborn. Fig. 3.

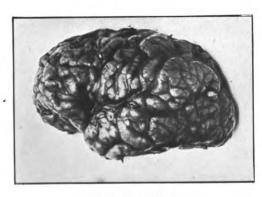


Fig. 4.



Infant aged six weeks. Fig. 5.

THE HISTOLOGICAL BASIS OF AMENTIA AND DEMENTIA.

To face p. 617.

DESCRIPTION OF FIGURES.

All the figures, excepting the microphotographs and figs. 16 and 17, are of the same relative size.

PLATE I.—Fig. 1.

Outer surface of the right hemisphere of Case 4, a male fœtus, aged a little over 4 months. Weight after hardening in formol 32 grammes. Whilst fissures exist, as is seen in the table of micrometer measurements (p. 571), with the exception of the fissure of Sylvius they are apparently largely of vascular origin.

Fig. 2.

Outer surface of the left hemisphere of Case 5, a feetus aged a little over 6 months. Weight after hardening in formol, 55 grammes. Note the presence of many of the secondary fissures. As is seen in the table of measurements (p. 572), the small vascular fissures referred to in fig. 1 are not now present. In the prefrontal region (see description of the case) lamination of the cortex has begun.

Fig. 3.

Outer surface of the right hemisphere of Case 6, a male full-term stillborn child. Weight after hardening in formol, 194 grammes. Note the upward direction of the somewhat open fissure of Sylvius, and the small size of the prefrontal region.

Fig. 4.

Outer surface of the left hemisphere of Case 7, a female full-term stillborn child. Weight after hardening in formol, 193 grammes. Both in its weight (which is equal to that of the male in fig. 3, instead of less) and in its much greater prefrontal development, the hemisphere is at a more advanced stage of development than is that of Case 6. This is seen also on comparison of the tables of measurements (pp. 573 and 574, figs. 7 and 8).

Fig. 5.

Outer surface of the left hemisphere of Case 8, an infant aged 6 weeks, which died of marasmus. Weight after hardening in formol, 161 grammes. Whether this child was full-term or not it is, of course, impossible to say, and the sex is also unknown. It is possible, in view of the feeble and emaciated condition of the child, that its cerebral as well as its general bodily development had been retarded. In the table of measurements (page 575, fig. 9) it will be seen that the deeper layers of the cortex are developed well beyond those in Cases 6 and 7, but that the pyramidal layer is not.

PLATE II.—Fig. 6.

Outer surface of the right hemisphere of Case 13, female, aged 56 years. Previous attack five years before admission. Died fifteen days after admission. No dementia. Group I., No. 9 of Part I. Weight after stripping, 495 grammes. Except for a small patch of old-standing sclerosis in the middle of the ascending parietal gyrus, there is little or nothing to indicate that the brain is not perfectly normal (p. 591).

Fig. 7.

Outer surface of the left hemisphere of Case 15, female, aged 36 years. Symptoms for nine years. A gross lesion of the right hemisphere, with resulting epileptiform convulsions, was present. The patient was an unstable case with little or no dementia. Group II., No. 34 of Part I. Weight after stripping, 488 grammes. Except for a little rounding off of the convolutions of the frontal lobe, the parietal lobules, and the first temporal gyrus, the hemisphere would readily pass for normal (p. 592).

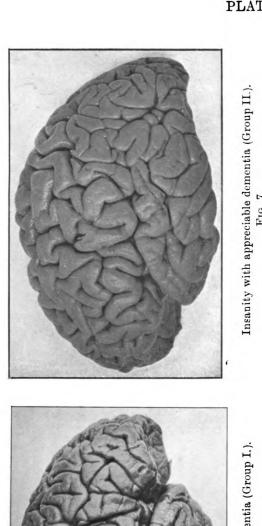
Fig. 8.

Outer surface of the right hemisphere of Case 16, female, aged 59 years. Symptoms for about eleven years. At first the patient showed a certain amount of mental confusion, and at the time of her death she was in a condition of chronic mania with dementia. Group III., No. 112 of Part I. Weight after stripping, 515 grammes. This hemisphere differs from those in the two previous figures in showing definite wasting, with marked rounding off of the convolutions in the frontal lobe, the parietal lobules, and the first temporal gyrus. Near the mid-line (not seen in the figure) the prefrontal region is more wasted than the remainder, but elsewhere no differentiation of the wasting is visible (p. 598).

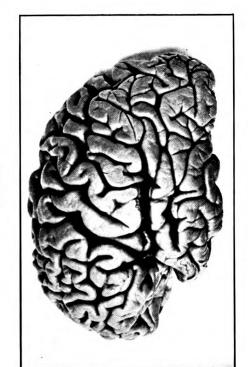
Fig. 9.

Outer surface of the left hemisphere of Case 17, female, aged 53 years. Previous attack at the age of 48, with probably no real recovery. A marked case of dementia. Group IV., No. 154 of Part I. Weight after stripping, 445 grammes. The hemisphere shows wasting, which is extreme in the prefrontal region, considerable in the sensori-motor area and the first temporal gyrus, fairly marked in the parietal lobules, and less marked elsewhere (p. 599).

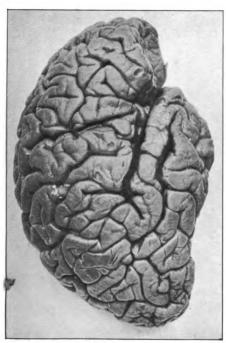
PLATE II.



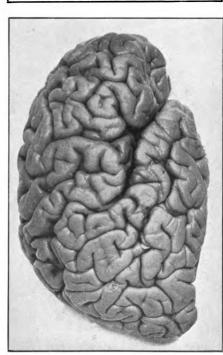
Insanity with appreciable dementia (Group II.). Fig. 7.



Severe dementia (Group IV.). Fig. 9.



Recurrent insanity without dementia (Group I.). $\label{eq:Fig.} Fig.~6.$



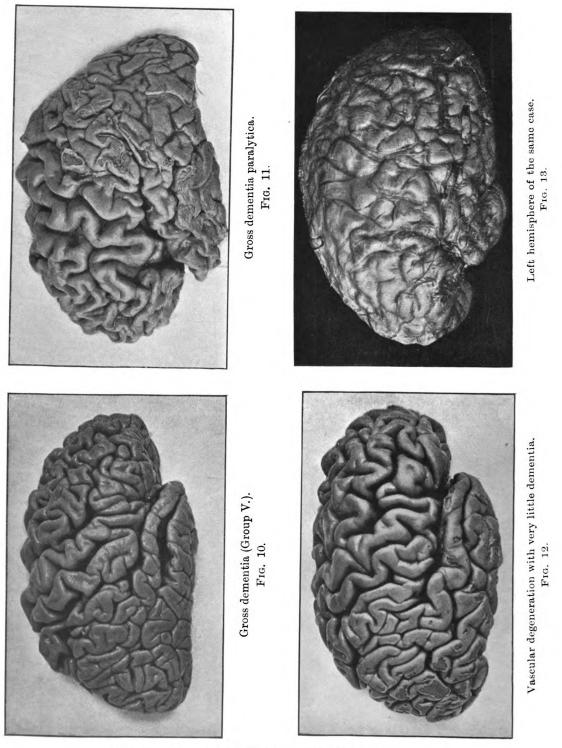
In sanity with moderate dementia (Group III.). Fig. 8.

THE HISTOLOGICAL BASIS OF AMENTIA AND DEMENTIA.

To face p. 618.

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PLATE III.



THE HISTOLOGICAL BASIS OF AMENTIA AND DEMENTIA.

PLATE III. -Fig. 10.

Outer surface of the right hemisphere of Case 19, female, aged 53 years. Seven years in the asylum. Died in a condition of gross dementia. Group V., No. 199 of Part I. Weight after stripping, 355 grammes. The hemisphere shows wasting, which is very extreme in the prefrontal region, extreme in the posterior thirds of the first and second frontal convolutions and Broca's gyrus, marked in the ascending frontal gyrus, almost or quite as marked in the first temporal gyrus and the superior and inferior parietal lobules, and moderate elsewhere (pp. 603-4).

Fig. 11.

Outer surface of the left hemisphere of Case 20, male, aged 41 years. Died of gross dementia paralytica. The duration of the disease appears to have been little if anything more than two years. Heredity. Syphilis. The case is unusual in having started with a long series of epileptiform convulsions, after which the patient rapidly became grossly demented. Weight after partial stripping, 475 grammes. The wasting is very extreme in the pre-frontal region, and extreme in the whole sensori-motor region (posterior thirds of the first and second frontal, Broca's, and the ascending frontal gyri), and in the first temporal gyrus, the superior parietal lobule, and the ascending parietal gyrus. The acute degeneration is most marked in the outer surface of the temporo-sphenoidal lobe, the inferior parietal lobule, and the pre-occipital region, but is marked elsewhere. This distribution shows fairly well in the photograph, but is much more clear in the actual hemisphere. The unusually early and marked involvement of the sensori-motor area was evidenced by the long series of convulsions which ushered in the disease. As a rule (see text) the first temporal gyrus and the parietal lobules are in gross and chronic dementia paralytica more wasted than the sensori-motor area, though this is not usually visible in ordinary gross dementia. This is probably due to the fact that the wasting in the latter is rarely so rapid and extreme as it is in the former, and consequently the differentiation in dementia paralytica is more likely to be the true one (p. 608).

Fig. 12.

Outer surface of the right hemisphere of Case 201 of Part I., male, aged 91 years. A case of senile decay with relatively little dementia, but most severe vascular degeneration. Weight after stripping, 485 grammes. Throughout the temporo-sphenoidal, occipital, and preoccipital regions there is marked decortication on stripping, and this distribution much resembles that in fig. 11, but is somewhat less extensive. The two brains differ entirely, however, in the amount of wasting present. In the present case there is a certain amount of wasting in the fronto-parietal region, and this offers a marked contrast to the gross wasting seen in fig. 11. The case is in itself a sufficient proof that severe vascular degeneration alone is unable to produce gross dementia, for the vascular disease present in this case was more extreme than the writer has ever seen. The hemisphere may also be usefully compared with the illustrations in figs. 9 and 10, which show the extreme prefrontal wasting of severe dementia. In the present figure it should be noted that such wasting as exists occurs, as would à priori be expected, in the same regions as the wastings of dementia (p. 483).

Fig. 13

This figure shows the outer surface of the left hemisphere of the same case. Attention is drawn to the immensely thickened and opaque pia-arachnoid, the chronic fibrosis and hypertrophy of which throughout the vault has gone far towards replacing the slow loss of cerebral tissue due to senile decay. The right pia-arachnoid for example weighed 65 grammes. Portions have been removed from the posterior thirds of the first frontal and second temporal convolutions and microphotographs of these are shown in the following two figures. The former illustrates the immense thickening of the pia-arachnoid, and the latter the more recent pial and neuroglial proliferation and the adhesion of the pia to the subjacent cortex.

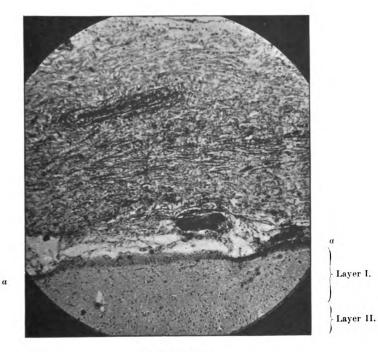
PLATE IV.—Fig. 14.

Microphotograph of the posterior third of the first frontal convolution of the same case in the position shown in fig. 13, 70 diameters. Note the immense thickening of the pia-arachnoid, which is composed of dense fibrous tissue, and in the opposite hemisphere stripped like a glove in this region. The line of separation is shown as an irregular lymphatic space in the photograph. This is inappreciable compared with the intra- and sub-pial spaces in gross dementia. At (a) is seen the extreme chronic hypertrophy of the superficial neuroglia, which has occurred pari passu with the hypertrophy of the pia-arachnoid. This neuroglia is highly fibrillated, and has to a considerable extent invaded (I.), the superficial layer of the cortex. At (II.) is seen the outermost part of the layer of pyramidal cells.

Fig. 15.

Microphotograph of the posterior third of the second temporal convolution of the same case in the position shown in fig. 13, 200 diameters. In this region, as is shown macroscopically in fig. 12, the pia-arachnoid is adherent to the underlying cortex, and decortication occurs on stripping. The thickness of the pia-arachnoid in this microphotograph is only about one twelfth of that in fig. 14. There is marked superficial neuroglial proliferation, which is of more recent date than that in fig. 14. The figure also shows considerable vascular proliferation. (I.) is the superficial layer of nerve-fibres, and (II.) the outermost part of the pyramidal layer of nerve-cells. In both this and the preceding section the nerve-cells are relatively normal in appearance and number, in comparison with what is seen in a case of chronic dementia-paralytica, although both chronic vascular change and chronic neuroglial proliferation are marked.

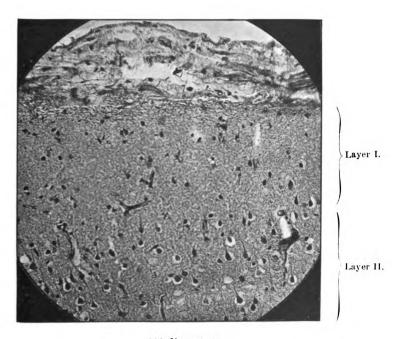
PLATE IV.



70 diameters.

First frontal convolution of fig. 13 in the position indicated.

Fig. 14.



200 diameters.

Second temporal convolution of fig. 13 in the position indicated.

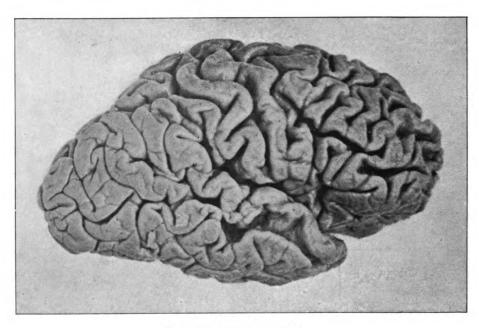
Fig. 15.

THE HISTOLOGICAL BASIS OF AMENTIA AND DEMENTIA.

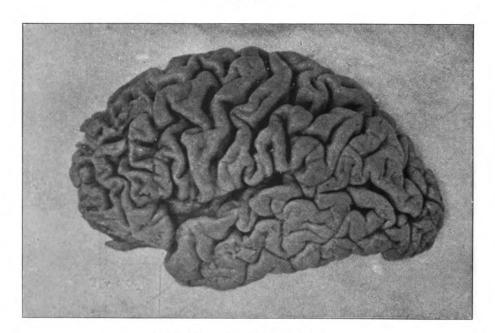
To face p. 620.

PLATE V.



Chronic dementia paralytica. Fig. 16.



More acute dementia paralytica. Fig. 17.

THE HISTOLOGICAL BASIS OF AMENTIA AND DEMENTIA.

To face p. 620a.

PLATE V.-Fig. 16.

Photograph of the right hemisphere of a case of chronic dementia paralytica, who died after a series of 198 epileptiform convulsions. The figure shows wasting which is very marked in the prefrontal region (anterior two-thirds of the first and second and anterior part of the third frontal gyri); marked in the first temporal gyrus, the inferior parietal lobule, Broca's gyrus, and the lower part of the ascending frontal gyrus; fairly marked in the remainder of the sensori-motor area and the superior parietal lobule, and relatively slight in the remainder of the hemisphere, including the orbital surface.

History.—Male, aged 53 years. Married eighteen years, no children. No family or personal history. In Claybury Asylum suffering from chronic dementia paralytica for nearly three years, during the greater part of which time he was lost to time and place and wet and dirty in his habits. During the last two years of his illness he had several series of convulsions, and eventually died after a succession of 198 epileptiform fits. Knee-jerks absent.

eventually died after a succession of 198 epileptiform fits. Knee-jerks absent. Left pupil greater than right, and both inactive to light. Tremor.

Post mortem.—Dura and S.D.—Slightly thickened. Recent subdural hæmorrhage and excess of blood-stained fluid. Pia.—Fronto-parietal opacity and marked thickening and congestion. Strips readily except on the postero-inferior aspect of the left hemisphere. S.A.—Excess of fluid. Vents. L.—Markedly dilated and granular. IV.—Granular throughout. Vessels.—Considerable thickening of the basal arteries. Encephalon, 1,225 grammes. Cerebellum, &c., 145. Right hemisphere, 500; stripped, 460. Left hemisphere, 520; stripped, 480. The right hemisphere was more severely affected than the left. Aorta exceedingly dilated, of cartilaginous density, and contains a large amount of pearly-white fibrosis and some calcareous deposit. Liver, spleen, and kidneys dense.

Fig. 17.

Photograph of the left hemisphere of a more acute case of dementia paralytica, who died of chronic tuberculous pneumonia. The figure shows wasting which is very extreme in the prefrontal region; extreme in Broca's and the first temporal gyri and the inferior parietal lobule, marked in the rest of the sensori-motor area and the superior parietal lobule; and less marked elsewhere, including the orbital surface of the frontal lobe. Decortication exists in the second temporal gyrus and the preoccipital region, into which parts the disease appears to be rapidly spreading.

History.—Female, aged 36 years, married. No family or personal history.

History.—Female, aged 36 years, married. No family or personal history. In Claybury Asylum suffering from dementia paralytica for thirteen months. On admission she was quiet and somewhat lost; she collected rubbish, and she was dirty in her habits. During her residence she had several (chiefly left-sided) convulsions. The pupils were unequal. The right knee-jerk was absent and the left was exaggerated. Facial and lingual tremors. Speech slightly slurred. Died in the last stage of dementia paralytics.

slightly slurred. Died in the last stage of dementia paralytica.

Post mortem.—Dura and S.D.—Natural. Great excess of fluid. Pia.—
Fronto-parietal opacity. Extremely thickened and gelatinous, and very adherent to the cortex. S.A.—Excess of fluid. Vents. L.—Immensely dilated, the left more than the right, and very granular. IV.—Dilated and granular, especially in the lower part. Vessels.—Natural. Encephalon, 1,045 grammes. Cerebellum, &c., 160 grammes. Right hemisphere, 393; stripped, 360. Left hemisphere, 355; stripped, 320. The left hemisphere was more severely affected than the right. Aorta natural. Liver, spleen, and kidneys dense.

PLATE VI.—Fig. 18.

The five microphotographs on this plate, which are all of exactly the same magnification, show the approximate depths of the pyramidal layer of nervecells in a fœtus of six months, a stillborn child, a marked ament, a normal woman, and a marked dement. These illustrations are only to be considered as very rough approximations, as, owing to the great variations in depth which exist in different regions of the cortex in any given case, it is only possible to arrive at a correct result after collating a large number of careful micrometric measurements.

Horizontal lines are drawn on the photographs to indicate the second or pyramidal layer, and the conjoined third, fourth, and fifth layers of the cortex. The first or superficial fibre layer is only partially shown in the illustrations.

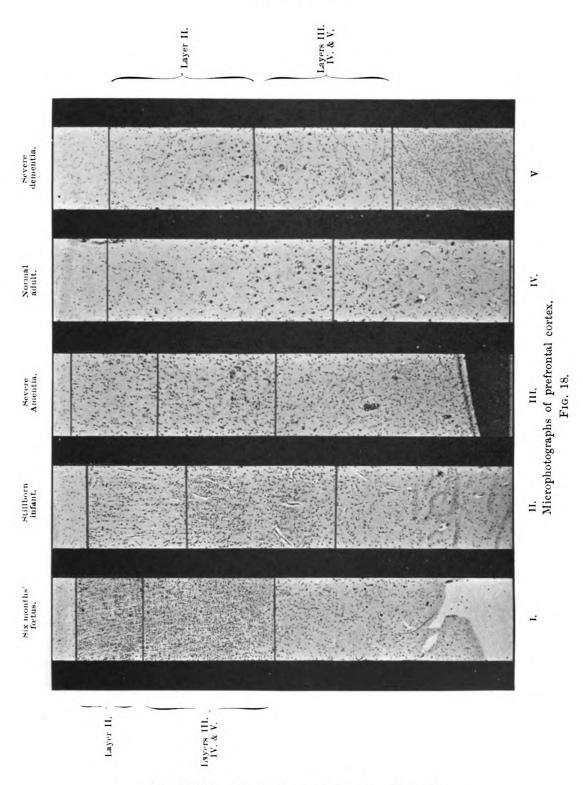
(I.) The prefrontal cortex of a feetus of a little more than six months. Differentiation of the cells into layers is just beginning, but no attempt has been made to demonstrate this in the photograph. The enormous number of cells should be noted, as also the relatively decreased depth of the pyramidal layer and the actual thinness of all the layers.

(II.) The prefrontal cortex of a stillborn male infant. All the layers are well differentiated and the different types of cells in the layers are clearly visible. The pyramidal layer is now relatively thicker than in the last case, but the cortex is much thinner than that of the adult.

(III.) The prefrontal cortex of a marked ament. The depth is very little more than that of the fœtus, and the cells, though fairly developed, are closely aggregated together, and show much irregularity in their arrangement. The layers can be made out, but are not very obvious to an inexperienced observer.

(IV.) The prefrontal cortex of an adult normal female. All the celllayers and also the types of cell are clearly visible, and the photograph markedly contrasts with those of the previous cases.

(V.) The prefrontal cortex of a marked dement. The cortex shows the adult characteristics, but all the layers are decreased in depth and the pyramidal layer is markedly decreased.



THE HISTOLOGICAL BASIS OF AMENTIA AND DEMENTIA.

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THE PATHOLOGY AND MORBID HISTOLOGY OF JUVENILE GENERAL PARALYSIS.

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THE following paper is founded (1) upon notes of the family, personal, and clinical histories of twelve cases of juvenile general paralysis, together with notes of the autopsies; (2) upon the study of the morbid histology of The cases came almost entirely from the Asylums of the London County Council and form part of the material at the disposal of the Claybury Laboratory. The facts revealed by the histories of the cases have been arranged and classified by the writer, and perhaps it is desirable to mention that the latter has had several years' experience of the clinical and pathological sides of alienism and has himself seen some thirty cases of the disease. In many instances the notes are very complete and show the type of case exceedingly well. In others it is to be regretted that important particulars have been omitted; this is scarcely to be wondered at seeing that the cases were derived from such varied sources, occurred during the ordinary routine of asylum work, and perhaps came under the observation of these who were not specially interested in the subject. has to be admitted also that in the study of the pathological histology of the earlier cases an insufficiently systematic examination was made, the writer having had no intention of contributing a paper in anything like the form which this has assumed. As the work progressed, however, certain facts came to light which have been more amply verified in the cases later investigated. The fact that the conclusions arrived at are in no sense à priori ones may perhaps enhance what value they have.

The writer desires to take this opportunity of thanking the Asylums Committee of the London County Council for permission to work in the Pathological Laboratory at Claybury. He cannot sufficiently acknowledge his indebtedness to Dr. Mott, F.R.S., for suggesting the line of work upon which he has been engaged, and for placing such a large amount of valuable material at his entire disposal; he has, moreover, had the great advantage of Dr. Mott's ever ready advice in matters of difficulty. The writer further wishes to express his great indebtedness to Dr. Bolton for many invaluable suggestions and particularly for that involving the use of his method of staining nerve-fibres. This method has been put to a most severe and thorough test during the course of the work upon these cases, and it is believed that anything like equally good results would not have been obtained by the use of any of the other fibre staining methods based upon the same chemical process.

The subject will be dealt with under the following headings:—

PART I.

Section A.—Etiological and Clinical (p. 622).

Section B.—Morbid Anatomy (p. 627).

Section C.—Morbid Histology. (I.) Of the Neurones. (II.) Of the Vessels. (III.) Of the Neuroglia, Migratory and other Cells (p. 629).

Section D.—Morbid Histology of the different parts of the Nervous System (p. 651).

PART II.

General remarks on the Etiology and Pathology (p. 664).

PART III.

Notes of the twelve cases individually (p. 675).

Part I.

SECTION A. ETIOLOGICAL AND CLINICAL.

(1) Etiological.

Although the histories of five of the cases up to a certain period have already been published by Dr. Mott in the first number of the Archives of Neurology, they may be usefully included in this summary, especially as in some instances additional facts have been obtained. From the full details collected of all the cases, the following points may be drawn attention to:—

(1) The parents in several instances married young, and there were a large number of pregnancies. Miscarriages and still-born children were frequent, and the number of children who survived to adult age was abnormally small.

Thus, in Case 8, the parents married at the ages of 22 and 20 respectively, and there were twelve pregnancies four of which resulted in miscarriages, and three of the children born alive are now dead. In Case 5, the parents married at the age of 24 years; there were fourteen pregnancies, including four miscarriages, and four of the children born alive are dead. In Case 11, the parents married at the age of 20 years, and had seven children—six of whom are now dead, including two born prematurely. In Case 6, seven out of nine children were still-born, and of the two born alive, both died young. In two instances the patient was the youngest of a very large family, and in another he was the eighth of nine children. In two cases details of the mother's pregnancies were not obtained, but in ten cases details of the pregnancies are complete. These show that ten marriages resulted in eighty-seven pregnancies, or 8.7 to each marriage. In twenty of these pregnancies miscarriages occurred, or the children were still-born, i.e., 23 per cent. Thirty-four of the children who were born alive died before the age of 25 years; many at a much earlier period, i.e., 50 per cent. So that of the total eighty-seven pregnancies. fifty-four resulted either in miscarriages, in the children being born dead or not surviving beyond the age of 25 years.

(2) A family history of insanity was obtained in six of the cases. In one case the father, and in another the mother of the patient died of general paralysis. In two instances no family bistory at all was obtained, and in general the family details are somewhat scanty, it being often difficult to get information on these points, especially in the case of pauper patients. Frequently brothers or

sisters of the patient were said to have died in infancy or childhood, from such troubles as "convulsions" and "meningitis," whilst others became epileptics.

- (3) A distinct family history of phthisis was found in six cases; one or other parent died of the disease in two cases.
- (4) Alcoholism in the father occurred in three cases. In Case 2, the patient's father became insane from drink, and is an inmate of Claybury Asylum, whilst his paternal grandfather and all his paternal uncles and aunts, as well as his maternal grandmother, were drunkards.

Thus out of ten cases in which family histories were obtained insanity occurred in six of these families, phthisis in six, and alcoholism in three.

(5) Eight patients had signs of congenital syphilis on the body. The mother of the patient had definite symptoms of syphilis in three cases. There were miscarriages and still-born children in the family histories of all the cases in which details were obtained, excepting two, and of these, in one instance the patient herself, and in the other one of the patient's brothers, presented marked signs of congenital syphilis. In no single case could the effects of syphilis be excluded.

The facts then, so far as these cases go, tend to show (1) that the juvenile general paralytic comes frequently of a prolific but degenerate stock; (2) that syphilis plays an essential part in the genesis of the disease.

The family histories of the cases recently published by Hirsch bear a striking resemblance to several of those included in the series.

In two cases the patients' condition was ascribed to a fall, but this, in each instance, may have been the result rather than the cause of the disease. Such factors as alcoholic excess, nicotine poisoning, "fast living," worry, specific fevers, and many others sometimes assigned as the causes of the disease, may, as a rule, be excluded from these cases, though not altogether in all of them. For example, two of the youths in this series are said to have been "drinkers," to some extent. Mercurialisation, recently suggested by Stoddart as a factor in the production of

general paralysis, may also, I think, in at least the majority of the cases, be excluded. The stress of puberty and adolescence, however, is probably extremely important, either in determining the time of onset of the disease or in hastening its progress.

(2) Clinical.

Sex.—Of the twelve cases, five were males and seven females.

Age at the commencement of the disease.—The youngest 12 years, the oldest about 19 years; the average 14 to 15 years. It is very difficult, however, to estimate the age at which the disease may be said to have begun in some cases, especially in the more imbecile patients.

Age at death.—The youngest 16 years; the oldest 25 years; the average 19 to 20 years.

Duration of the disease.—The shortest was one and a half years, the longest nine years and the average about five years. Intercurrent diseases such as phthisis were present in some instances but probably had not much effect on the progress of the cases, as all had arrived at a stage of extreme dementia and paresis before death. Those cases in which the disease began latest as a rule ran the most rapid course. Also those few cases in which epileptiform convulsions occurred comparatively early in the disease terminated more quickly. The two patients who lived longest after the onset of the disease, viz., nine and seven years respectively, did not have convulsive seizures, or such occurred only during the last three months of life.

Physical condition.—All the patients presented typical signs of general paralysis and these need be but little dilated upon. Some history of convulsive seizures was obtained in six of the cases, but the seizures usually occurred late in the disease and were not generally of a severe character. In this particular the juvenile cases appear to approach more closely to the type of the disease as seen in the female adult general paralytic than in the male. It may be mentioned that pronounced optic atrophy was found in four out of the twelve cases, a higher proportion than is met with in adult

general paralysis, excluding the tabetic variety. Paralytic symptoms in the majority of the cases did not appear particularly early, nor were hemiplegias and "paralytic strokes" common. Alzheimer has concluded that the latter are relatively rather more frequent than in the adult form of the disease.

Stigmata of degeneration are described in many of the cases; in others the notes on this point are, unfortunately, very incomplete. Menstruation in the females either did not begin, or was very irregular and ceased early in the course of the disease.

The genital organs in almost all the cases were found to be in a state of immaturity compared with the age of the patient.

Mental state.—The cases may be divided into two groups:

(1) Those patients whose intelligence previously to showing signs of the disease was equal or nearly equal to the normal.

(2) Those patients who were congenitally deficient in intellect. These were usually fairly high grade imbeciles, never idiots.

In Group I. may be included Cases 8, 9, and 10, who all passed a satisfactory standard at the Board School and were able to earn their own living. Case 5 may also be included in this group, because although she became blind she was readily taught and showed no defect of intelligence up to the time of onset of the disease. Case 4 also seems to have possessed ordinary intelligence. In Group II. Cases 1, 3, and 7 may be included; they could be taught very little although they were able to do housework. Cases 2, 6, and 12 are difficult to classify. They seem to have been somewhat deficient in intellect, but were able to earn their living for a time.

Hirsch states that in cases of juvenile general paralysis some degree of weakness of intellect is apparent during the stage of childhood. This by no means always appears to be so. On the other hand, looking back on my own clinical experience, I am inclined to think that the disease does occur even amongst lowest grade imbeciles, but that owing often to its atypical character and the extreme chronicity

of its course in these cases, it is very liable to escape recognition.

The one constant and characteristic feature from the mental side was progressive enfeeblement, and all the patients before death had become extremely demented. Delusions were common in the earlier part of the disease. These were of a grandiose type in two cases, and these patients, the two most intelligent of the series, were unduly exalted. Delusions of persecution were not infrequent, and delusions on religious topics were present in one case. Hallucinations of hearing occurred in some cases. Attacks of excitement were not of frequent occurrence.

Remission did not take place in any instance. I have never noticed true remission of the symptoms in any case which has come under my personal observation, and am therefore inclined to think that remissions occur only rarely, if at all, in this form of the disease.

Section B. Morbid Anatomy.

In one case no post-mortem notes are at the present time available, and it is to be regretted that in some other cases, whilst many important particulars have been obtained, the notes are still incomplete. In at least six cases, however, very full accounts have been obtained. The following is an analysis of the appearances seen in the eleven cases of which I have notes. The dura was frequently natural, in some cases slightly thickened and adherent to the calvarium. In no instance was there any subdural deposit; in this particular also the cases approach more nearly in type to the female adult general paralytic than to the male. Every case showed excess of subdural fluid, and in five cases very great excess is recorded. In most there was excess of intra- and subarachnoid fluid, and in several cases the excess was considerable. The pia-arachnoid in every instance was thickened and opaque, particularly in the fronto-parietal regions, and where stripping was attempted was usually adherent. Midline prefrontal adhesions were constantly present. The lateral ventricles were invariably dilated and frequently granular. The fourth ventricle was always typically granular, including its lower half. Of the vessels and sinuses little can be said excepting that in one case there was marked thrombosis of several of the large pial veins, with less complete blocking of the sinuses.

The weight of the brain was almost always considerably below the normal. The hemispheres were separately weighed in the fresh state in five cases only. The left weighed less than the right in four of these, the greatest difference amounting to 28 grammes. In the other case the left hemisphere weighed 20 grammes more than the right. The cerebral convolutions were often of a somewhat simple type, in some instances very distinctly so. As the soft membranes were rarely completely stripped, it was difficult to exactly localise the areas in which most wasting of the convolutions had occurred. In general terms, however, the atrophy may be said to have been greatest in that part of the brain anterior to the ascending frontal convolution, particularly the prefrontal region. It was less marked usually in the superior and inferior parietal lobules and in the upper parts of the temporal area, but these regions were more involved than the central and occipital. Marked atrophy of the optic nerves was seen in four cases. The spinal cord was generally small.

Active tubercular disease of the lungs was found in five cases (four male, one female). In one case acute and chronic dysenteric ulceration was observed, and in another a recent dislocation of the hip joint was present. The stomach and intestines are described as normal, excepting in the abovementioned case of dysentery, in another case in which tubercular ulceration occurred, and in two other cases, in one of which there was some patchy congestion, and in the other this condition, together with some "atrophy" of the mucous membrane of the intestines.

With regard to the signs of syphilis found post mortem, in addition to such evidence as that afforded by the condition of the teeth, of rhagades about the mouth, &c. (usually described during life), the following were recorded: The skull exhibited prominence in the neighbourhood of the sagittal and coronal sutures in three cases. Interstitial keratitis and chorio-

retinitis occurred in two cases. Atheroma of the aorta is described in five cases, a very unusual condition in patients of the age of those in this series. In some the state of the aorta is not mentioned. In several cases there was abnormal density, sometimes very marked, of the spleen, liver, and kidneys, usually in this order as regards relative degree of affection. An undeveloped state of the genital organs is noted in several of the cases.

Thus in all the cases, excepting one, at least some evidence of syphilis was found either during life or after death. In the excepted case the notes are incomplete upon the point, but the patient's mother had definite signs of syphilis, and her father died of general paralysis.

SECTION C. MORBID HISTOLOGY.

The following account deals entirely with the nervous system. The material upon which it is founded being gathered from various sources, in two cases the brain only was obtained, and in another case only a portion of the Rolandic area. There has not yet been time to complete the examination of all the material which has been collected, especially is this so with regard to the cranial and peripheral nerves and the organs other than those belonging to the nervous system, excepting in one or two cases.

Methods.—The nervous tissues, as a routine practice to ensue uniformity of results, were hardened in 5 per cent. formalin, those sent to the laboratory having been hardened in this manner. Portions required for the Marchi method were subsequently placed in Müller's fluid. Where possible fresh blocks of tissue were placed at once into 96 per cent. alcohol and others into corrosive sublimate solution to be used as controls. The staining methods chiefly employed were methylene blue, and the latter with saffranin, erythrosin and methylene blue, and polychrome blue; all after the method of Nissl. The Heidenhain iron hæmatoxylin method was constantly used, especially in conjunction with slow counter-staining by erythrosin, this being found particularly useful for the demonstration of changes in the neuroglia. Staining with logwood and eosin and by the methods of van Gieson and of Streebe have also been freely employed. The Ehrlich-Biondi method and the method of Cox have also been used in some instances. For showing recent degeneration in the nerve-fibres Marchi's method was made use of, whilst for revealing the chronic changes in the nerve-fibres Bolton's modification of the Weigert-Pal method upon Marchi stained sections was, for reasons to be afterwards given, entirely relied upon. When the Nissl method was used the sections had been cut after embedding in paraffin. The Marchi stained blocks were cut after celloidin embedding, and in some instances after paraffin embedding for the purpose of obtaining thinner sections. Further details as to methods will be given later where necessary.

Post-mortem changes could, as a rule, be almost entirely excluded, especially in the five cases from the Claybury Asylum, the bodies in these instances being placed in the cold chamber shortly after death. In Cases 7 and 11 it is feared that post-mortem changes did interfere to some extent with the appearances in the nerve-cells, and these have been duly discounted.

(I.) Morbid Histology of the Neurones.

It is proposed in this section to give merely a general account of the morbid changes affecting the neurones, those of the cerebral cortex particularly. Further details as to the affection of the different parts of the nervous system examined will be found in Section D.

(1) Changes in the Nerve-Cells.

The character of the degeneration found in the nerve-cells may be roughly divided into chronic and acute, although for reasons to be afterwards mentioned it is sometimes not easy to draw such a sharp distinction, and to determine with precise accuracy the type of change which affects any given cell. Some of the changes described are illustrated in the accompanying plate.

Chronic degeneration of the nerve-cells was seen in all the cases, and in certain of them, viz., those with only moderate vascular disturbance, the changes in the cells appeared to be either entirely of this character, or the more acute changes were evidently of very recent origin. The earliest alteration observed is some chromatolysis, which most often seems to begin at one side of or at the base of the cell (although frequently it is perinuclear or diffuse), and next gradually involves the protoplasmic processes. The cell becomes

shrunken, the processes atrophy and tend to become tortuous, the apical process especially. The nucleus is little altered at first, but the nuclear network soon appears to disintegrate, and the nucleolus to pass towards the periphery of the nucleus. As the chromophile elements disappear the cellular reticulum becomes more visible and then breaks down. The nucleus loses its central position and may be displaced to almost any part of the cytoplasm. It also becomes shrivelled looking, its membrane folded, irregular, and perhaps broken. At a later stage the cell is represented merely by a shrunken irregular nucleus, attached to which is some diffusely stained cytoplasm, or a few shreds of broken down reticulum. Finally, only a practically free nucleus is left. The nucleolus also diminishes in size, but its presence generally can be made out, even when the nucleus is virtually free. The nucleus appears to persist, though in an altered form, after practically total disintegration of the cell body. Therefore, cells in which the nucleus is apparently entirely or almost entirely absent, whilst the body of the cell is comparatively unaffected, have not been considered, as it is probable that such cells are merely very incomplete sections of "whole" cells.

A striking feature in these juvenile cases is the general absence of pigment in the degenerated cortical nerve-cells. Some cells are seen which contain a little yellow or brownish-yellow slightly granular pigment, amongst which is usually scattered a number of small particles of chromophile substance. These cells are, however, relatively rare, and the amount of pigment they contain is small in quantity compared with that seen in the nerve-cells of the adult general paralytic, or with that found, say, in the anterior horn cells of the spinal cord in these juvenile cases. It would appear, then, that the development of pigment in the nerve-cell is to some extent a question of age rather than of degeneration. The pigment when present stains brownish-black in Marchi preparations, and black in those by the Marchi-iron-alum-Pal, and Heidenhain methods.

Acute degeneration.—In certain of the cases, whilst many of the cortical and other nerve-cells show chronic de-

generation, others exhibit changes of an altogether different character to those above described. These cases show marked congestion of the vessels and great increase of cerebro-spinal fluid with cedema of the brain. The acute alterations seen in the nerve-cells in such cases are of at least two types:—

- (a) Swelling of the cell and chromatolysis, with sometimes vacuolation.
 - (b) Coagulative necrosis.
- (a) Swelling of the cell and chromatolysis.—In the first type of change the cell is in its earlier stages merely swollen-its sides having a "plumped out" appearance, the nucleus and nucleolus being also more or less enlarged. former is pale in colour, and the nuclear network is unusually distinct. Sometimes the swelling of the nucleus is enormous, and it occupies almost the entire cell; especially is this the case in the smaller and medium sized cells. nucleolus is also often greatly increased in size, and stains very deeply, with the exception usually of a small clear refractile area. At this stage or a little later there is commencing chromatolysis in the cell, the chromophile elements disintegrating usually first at the periphery of the cell and along the protoplasmic processes, which latter sometimes show irregular varicosities. Later the outlines of the cell appear to be broken and ragged, and the chromatolysis is more advanced. Perhaps only a few irregular Nissl blocks remain in the neighbourhood of the nucleus, the rest of the chromophile elements being broken down into very fine particles, either diffusely distributed throughout the cytoplasm, or arranged in fine lines as if encrusted upon the delicate threads of the cellular reticulum. The latter itself appears to stain deeply in many cells. The nucleus, even before this stage is reached, may often be observed to have moved towards the periphery of the cell, and later, with destruction of the reticulum, it becomes more or less extruded. I have never, however, seen total extrusion of the nucleus. In a more advanced stage the chromatolysis and breaking down of the cellular reticulum is more complete, and little may be left of the cell excepting a still swollen nucleus

with perhaps a few shreds of stained reticulum adherent to it. Much earlier than this the nuclear network disintegrates, and the nucleolus tends to take up a position nearer the nuclear membrane. Many cells may have a less swollen appearance, both as regards the cell body and the nucleus, and the chromatolysis is less evident. In such cells the nuclear membrane may be more irregular in contour, and often one or more distinct deeply stained lines may be seen passing wholly or partially across the nucleus as described by Roncorini. Cells presenting these appearances may possibly have been more swollen, but are tending to become dehydrated and to recover, the nuclear membrane then being thrown into folds.

In certain cases, and especially in those in which the ædema of the brain was very marked, many of the nervecells, in addition to being greatly swollen, present vacuoles, or what appears to be such, in the cytoplasm. There may be only one or two very large vacuoles, or several smaller ones in the cell. The nucleus in such cells is usually only moderately swollen, and often tends to stain diffusely, the nucleolus being more or less obscured. Sometimes when the vacuoles are large the nucleus appears to be pushed up into one corner of the cell and to be very irregular in outline. The vacuoles are, as a rule, clear, but often in methyl blue preparations appear to contain some material of a very pale yellow colour, and occasionally distinct brownish-yellow granules are seen in the vacuoles. I have not observed vacuolation affecting the nucleus. In these cases vacuolation is seen not only in the cortical nerve-cells, but also in those of the dentate nucleus of the cerebellum, and, though with much less frequency, in the cells of the pons, medulla, and spinal cord.

Such changes as above described are probably due to processes of hydration and dehydration occurring in the cells. The different appearances seen may be partly explained by the varying stages of these processes which the cells have reached, and partly, perhaps, by the condition of the cell antecedent to its being subjected to the effects of cedema. The aspect of the cell which was previously comparatively

healthy would differ considerably from that of a cell which was in an advanced state of chronic atrophy, were both cells to become ædematous of the same time.

This swelling and chromatolysis of the nerve-cell affects all the layers of the cortex in certain cases, but the condition is most frequent and most advanced in the smaller cells.

In experiments performed by the writer with a view to studying the acute effects of ricin and abrin upon the nervecells of animals, very similar changes were found to those above described, although there are some differences in the appearances seen which need not be detailed here.

(b) Coagulative necrosis.—In the second type of acute change found in these cases, the appearances are totally different from those seen in the first type. The cell may be either swollen or shrunken, very frequently the latter. Both the cell body and the protoplasmic processes stain very diffusely and intensely with methyl blue and a dull purple colour with polychrome blue or with methyl blue and saffranin. The nucleus is often not visible or can only be distinguished with difficulty; frequently the nucleus appears to be in the condition of "homogeneous degeneration" described by Sarbo. Occasionally in the concavities of the irregular border of the cell deeply stained granules are seen. These latter appearances seem to correspond to some extent with those described by Marinesco, as occurring in cases of encephalitis, under the term "superficial coagulation with corpuscular formation." He ascribes the condition to disturbance of nutrition from circulatory troubles. Coagulative necrosis is more rarely seen in these cases of juvenile general paralysis than is the change in the nerve-cell, due to ædema, and it is confined so far as I have observed almost entirely to the fairly large and medium sized pyramidal cells of the cortex cerebri. Also it was only noticed in those cases in which the signs of congestive disturbance were most intense.

The opportunity has been granted me by Dr. Mott of examining a large number of his sections of the central nervous system of animals which were experimented on by Dr. Leonard Hill with a view to the production of cerebral anæmia by the ligature of the cerebral arteries. The effects of

the anæmia in different animals varied from a few minutes to several days in duration. Dr. Mott in his Croonian Lectures has described the appearances of the nerve-cells in these anæmic brains and has pointed out how closely they resemble those seen in the cortical nerve-cells of the human subject under certain pathological conditions. I have carefully compared the appearances of the cortical nerve-cells in these experimental cases with those seen in normal animals and with those found in juvenile general paralysis. The alteration in the nerve-cells in these experimental conditions are practically indistinguishable from some of those seen in certain cases of general paralysis and described above as acute changes. Further, in those animals which lived for a sufficient length of time after the cerebral anæmia was produced recently degenerated nerve-fibres were seen by the Marchi method in the efferent tracts of the pons, medulla, and spinal cord, such fibres probably corresponding to the cortical motor cells which had perished as a result of the anæmia. Similarly in those cases of general paralysis in which a considerable number of the cortical motor nerve-cells show acute destructive changes, a correspondingly greater number of the efferent nerve-fibres exhibit recent degeneration throughout their entire course.

I do not propose at the present time to enter into the question of the mechanism of the production of the acute cell changes in general paralysis. Such changes appear to be at least partly dependent upon the circulatory disturbances which so frequently take place during the course of this disease. That these disturbances are often very intense is shown by the great venous congestion so frequently seen; even thrombosis of the veins is not uncommon in general paralysis and I have already met with several cases in which this occurred to a marked extent. Case 7 of this series is an excellent example of this condition.

The acute nerve-cell changes occur only in scattered foci, although in some cases a very large number of cells are affected. Generally amongst the acutely degenerated cells others are seen which are comparatively healthy or are in various stages of chronic degeneration. Often two cells adjacent to each other present totally different appearances.

Although general paralysis is a disease in which one would expect to find acute degeneration affecting the nervecells in certain cases, such degeneration does not appear to have been recognised by many writers on the subject. Recent degeneration in the efferent projection nerve-fibres has been noted by many observers in cases of general paralysis, especially those with convulsive seizures; but any acute degeneration in the nerve-cells of which these fibres are the axones has not usually been described in these cases. Some of the appearances seen in the acutely changed cells -especially, perhaps, vacuolation-are no doubt virtually artefacts; yet they have, I think, a distinct comparative value for the following reasons:—(1) The changes cannot be accounted for by post-morten decomposition, because they occur in cases in which the body was placed in the cold chamber shortly after death, and are seen in perfectly fresh animal tissues. (2) Fixatives or hardening agents such as formalin, 96 per cent. alcohol, and corrosive sublimate, produce no essential difference in the appearances seen. (3) The acute cell changes occur only in scattered foci, are marked and extensive only in certain cases, and especially only in certain conditions of the nervous system as regards vascular disturbance and cedema. (4) The amount of recent degeneration in the nerve-fibres is always much greater in areas in which the acute nerve-cell destruction is marked than in areas in which this latter is slight or absent; the recent degeneration in the nerve-fibres as shown by the Marchi method being probably largely the result of acute or subacute destruction of the corresponding nerve-cells at some relatively recent previous period.

Hence it is probable that the acute cell changes are of much importance in the pathology of general paralysis. It is known that in animals cells so affected up to a certain stage may recover, and it is not unlikely that many cells so involved in general paralysis do recover, or partially recover, time after time until they finally succumb. This may account for some of the clinical phenomena of the disease, e.g., temporary paresis, aphasia, state of stupor, &c. It is interesting to note in this connection the condition of the

cortical nerve-cells in certain of the animals which were experimented on by Dr. Hill, and which were allowed to survive for several days after the ligature of the arteries. These animals were stupid and paretic at first, but subsequently completely recovered. Most of the cortical nerve-cells were then found to have become restored to their normal condition, or nearly so—a very different state to that in which these cells were found in animals which were killed during the stage of paresis.

The writer does not wish to be interpreted as asserting that in every case of venous congestion and cedema of the brain extensive acute changes will be found in the nervecells. In the experimentally produced anæmia the conditions were very gross, and seldom if ever occur to such a grave extent in the human subject. Further, much appears to depend upon conditions of metabolism and states of specific resistance of the individual nerve-cells. The effects of acute vascular disturbance upon a nerve-cell which is either prone to degeneration, or is already affected by some degree of previous change, has to be considered. Hence sometimes the difficulty in making a definite distinction between acute and chronic alterations. For instance, a nerve-cell may show great swelling, with very definite perinuclear chromatolysis; this may represent either ædema of a cell already affected by a chronic degenerative process or a change of a totally different character, possibly toxemic in origin. It would appear, then, from the foregoing that a slow atrophic degeneration is the primary and essential change as far as the nerve-cell is concerned in general paralysis, but frequently large numbers of nerve-cells are destroyed by a more acute or subacute process.

(2) Changes in the Nerve-Fibres.

Methods.—The Marchi method was in all the cases, excepting one, employed to demonstrate the recent degeneration in the nerve-fibres. For showing the chronic degenerative changes, in the cerebral cortex especially, Bolton's modification of the Weigert-Pal method upon sections from the Marchi stained blocks was entirely relied upon. Details of the processes adopted

will be given because the writer believes that they are essential in the production of results similar to those which he has obtained. Sections from the Marchi stained blocks were further mordanted in iron alum, or ammonium molybdate solution for two days in the incubator; after washing until clear they were stained for at least two days (in the incubator) in Kultschitzky's hæmatoxylin, and then very slowly and carefully differentiated according to Pal's method, using half or quarter strength of the permanganate solution, with frequent alternation of the permanganate and sulphite baths. The sections were mounted, after being washed for a short time only in tap water. The objection to the method as thus used is that often the sections are apt to become very brittle and require very careful handling; sometimes one has to be satisfied with rather broken specimens. It may be mentioned here that often the cortex of the general paralytic exhibits great resistance to mordanting, and that, therefore, the resulting lake is apt to be very easily washed out. Hence, sometimes, it is almost impossible to obtain anything like a true picture of the state of the whole of the nerve-fibres in any one section. If the section is differentiated sufficiently to reveal the deeper radial and interradial fibres, the stain will probably have become cleared out of very many of the fibres that remain in the more superficial cross layers. These latter may thus erroneously be concluded to be much fewer in number than is actually the case. If, on the other hand, the section be differentiated just sufficiently to show the more superficial horizontal fibres, so much lake is left in and about the deeper fibres that these latter are obscured. Therefore, in some cases, where there is difficulty in staining the nerve-fibres it is necessary to examine sections which have been differentiated to different degrees before forming conclusions as to the condition of these fibres. The trouble often experienced in satisfactorily mordanting and staining the nerve-fibres of the general paralytic cortex probably arises as much from the frequent state of cedema of the tissues as from conditions of degeneration in the fibres. In the cases which I have investigated the tissues, in addition to being chromed, were subjected to the double mordants osmic acid and either iron alum or ammonium molybdate. The two latter salts are especially valuable in assisting to reveal the finer nerve-fibres of the cerebral cortex; sometimes one gives rather better results than the other. The ordinary Weigert, the Weigert-Pal and similar methods are, I think, quite unreliable for the study of the nerve-fibres, especially those of the cross layers, in the cortex of general paralytics. The dependence

upon such methods has, I believe, led to the formation of many erroneous conclusions upon this subject. No more striking proof of this could be obtained than that to be found in some of my own preparations. Sections from a certain cortical area stained by the Weigert or Weigert-Pal method may exhibit apparently an almost complete absence of the more superficial cross fibres, which, however, in sections stained by the Marchi-iron-alum-Pal method, can be shown to exist in abundance. It is a much easier matter to fail to stain the nerve-fibres and conclude that they are absent than it is to successfully stain them and demonstrate their presence. The positive conclusion then being of much more value than is the negative, and bearing in mind the difficulties in staining the nerve-fibres of the general paralytic's cortex, I think that one should be very careful not to assert that the nerve-fibres in any given area are atrophied until very special effects have been made to reveal their condition. As the Weigert-Pal process is still so frequently referred to as a "specific" or "unique" method for the staining of medullated nerve-fibres, it may be here insisted upon that, as clearly shown by Bolton, the process is really nothing of the kind. It is merely a method of dying fibrils-medullated or otherwise. "This consists of three distinct operations: the mordanting the fibrils, the formation of a lake in them, and finally the removal of the stain by oxidation from nearly every other part of the complex tissue." As a matter of fact, the medullated sheath may or may not stain, according to the mordant used.

Recent Degeneration of the Nerve-Fibres.

(1) Of the cerebral cortex.—In some of the cases included in this series recent degeneration of the radial fibres was found in practically all of the cortical areas examined, but was usually most evident in the central and occipital regions. In the cases which showed gross vascular disturbance a very large number of the radial fibres were so affected. In other cases in which the vascular congestion was not so marked the recent degeneration of these fibres was comparatively slight, and limited to the central and occipital cortex, and in some instances it was practically absent, or confined to the central region of the cortex. Thus there seems to be a close connection between the amount of the vascular disturbance and the amount of recent fibre degeneration, just as there is

between the former and the extent of the acute nerve-cell The radial fibres were the only ones showing recent degeneration in many cases. In others a few of the interradial fibres appeared to be affected, especially the thicker ones; possibly these latter belong to the secondary system of The other horizontally coursing fibres appeared to have escaped. I have examined a large number of sections of the cerebral cortex stained by the Marchi method in various diseases, but have not found definite evidence of recent degeneration affecting the tangential and superradial fibres Although in some cases these fibres could in any instance. be shown to exist by the Marchi-iron-alum-Pal method, and to be in various stages of chronic degeneration, yet the Marchi method did not reveal any recent change in the fibres. Many of these fibres certainly appear to be nonmedullated, but great numbers of others exist which are wholly or partially medullated.

(2) In all the cases the fibres of the efferent tracts showed more or less recent degeneration. Sometimes this was slight, but in several instances very many fibres belonging to these tracts were involved in all parts of their course examined. The afferent tracts were invariably less affected; in some cases recent changes in these were practically absent. The changes in these tracts, however, together with those in the systems of long and short association fibres, and in the fibres of the cerebellum, will be more fully described under the separate headings.

Chronic Degeneration of the Nerve Fibres.

(1) Of the cerebral cortex.—In all the eleven cases in which the cortical nerve-fibres were examined at least some degree of atrophy of the fibres, especially of the horizontal systems, is seen in all the areas investigated. In some cases specimens from the occipital and central cortex exhibit an abundance of fibres; comparative examination, however, shows them to be diminished in places, and presenting some degrees of degeneration. This atrophy of the fibres is usually very patchy in character; one gyrus may show abundant and practically healthy fibres, whilst in the next gyrus, or part of it, the

fibres may be scanty and considerably degenerated. This cannot be accounted for by the effects of differentiation of the specimens, because in several sections from the same block, stained in the same manner, and differentiated to different degrees, the area of greater degeneration always appears in the same portion of a gyrus. Hence it is advisable to examine large sections embracing at least three or four gyri, or, better still, more than one block from the same area, before arriving at conclusions upon the state of the fibres in The patchiness of the atrophy may be due to vascular changes, the nerve-fibres tending to be affected in scattered foci as are the nerve-cells. In endeavouring to estimate the amount of chronic degeneration affecting the fibres mere relative "scantiness" has not alone been trusted to, but such conditions as a tendency to appear broken into shorter lengths, to be tortuous and excessively varicose, have also been considered.

With regard to the systems of cortical fibres affected, the radial fibres were invariably in these cases less involved than the horizontal fibres. In some instances, in fact, the radial bundles in the central and occipital cortex appeared to be practically normal, reaching almost into the molecular layer. Often, however, there was more or less chronic degeneration of these fibres, and in the cortical areas most affected, particularly in the prefrontal region, the radii showed very advanced degenerative changes. The radial bundles were then thin and fell very short, the individual fibres being broken, uneven, tortuous, and excessively varicose. The terminals of the radii were always more affected than the trunks.

The fibres constituting the horizontal systems were always at least somewhat diminished and degenerated, although in some cases, in parts of the central and occipital cortex, they approached nearly to the normal. Of the different cross layers, the superradial were generally the most affected. In some cases the superradial were considerably more atrophied than the tangential and interradial fibres; in others the tangential were about equally affected with the superradial, but in no instance were the former

more atrophied than the latter. The interradial fibres and those of the line of Baillarger appeared to persist much better than the other cross layers. When the interradial system was found to be grossly affected, the more superficial horizontal layers of fibres had practically disappeared. The cross layers of fibres, especially the tangential, seemed to be generally rather less affected along the sides and bottoms of the sulci than along the flat surfaces of the gyri. Of the tangential system proper, the fibres which first appeared to be affected were the long coarse fibres of the second system of Kaes. These tended to become curly, excessively varicose, and appeared broken into shorter lengths, whilst often they seemed to have disappeared, although vast numbers of the medium and fine fibres of the layer persisted. I am inclined to think that these coarse fibres generally atrophy earlier than the medium sized and finer fibres, and to distrust those specimens which show persistence of the thick fibres and disappearance of the finer ones, believing that in these instances the "stain" has failed to reveal the presence of these latter very elusive structures. Certainly many of my preparations show considerable diminution or absence of the coarse fibres, with persistence of enormous numbers of the medium and finer ones. The relative degree of degeneration of the different systems of cortical nervefibres appears to correspond very closely with the order of their development as given by Kaes—the later developed systems being the most affected.

(2) The condition of the fibres of the cerebellar cortex as regards atrophic changes and the sclerosis found in the efferent and afferent tracts and in other parts will be described under separate headings.

(II.) Morbid Histology of the Vessels.

This subject will again be dealt with chiefly as regards the cerebral cortex. The same general statements, however, apply to the other parts of the nervous system examined.

From the point of view of structural changes in the vessel walls the cases may be roughly divided into two groups—(1) Those showing only a moderate amount of

change; (2) those with considerable change—the majority of the cases. These latter, however, varied a good deal in the amount and extent of the involvement of the vessels, and the two groups naturally shade into one another. In the cases included in the first group some vessels, especially the arterioles and capillaries, showed a fair amount of proliferation of their adventitial and endothelial cells, but little evidence of hyaline fibroid degeneration; other vessels, including the capillaries throughout the cortex, appeared to be practically normal. There was some evidence, then, of an arterio-capillary lesion in every case.

In the cases included under the second group alteration in the vessel walls was seen in varying degrees. A very large number of vessels showed some proliferation of all the elements of their coats, and often this was very great. Hyaline degeneration was, however, frequently slight; sometimes well marked, but never very pronounced. The pial vessels and those in the outer layer of the cortex were usually most affected. The arterio-capillary lesion, even in the worst cases, was scarcely, I think, so severe and widespread as that seen in most instances of the adult form of the disease. It would appear, then, that two degrees of change occur in the vessel walls—one a chronic reparative process, shown chiefly by the hyaline change, the other an active proliferation, much more recent in origin.

One or two further details may be briefly alluded to. As has been said in the cases under Group I., many vessels could be seen which have a practically natural aspect. In other vessels, taking the capillaries, the only noticeable change in many was that some of the endothelial nuclei had lost their normal elongated shape, had become more oval, had altered in their staining reactions and had approximated closely to the appearance of the endothelial nuclei of the fœtal cerebral capillaries. In other instances these nuclei had become very much enlarged, of various shapes, and many could be seen evidently undergoing division or but recently divided. In the more severely affected of the larger vessels this proliferative process had involved other elements of the vascular coats. In the cases under Group II. a very marked prolifera-

tion of most of the elements in and about the vascular walls was visible in the majority of vessels, with evidence of the formation of new vessels. In the somewhat larger vessels it would appear that almost all the mesoblastic cell elements of the vessel walls, together with those lining the perivascular channel, and the surrounding neuroglia have taken part in this proliferative process, so that the vascular channel becomes in places almost entirely blocked by these newly formed cells and by cells of the type of certain of the formed elements of lymph. A characteristic feature in many cases is the crowding about the vessels of the cerebral cortex of numerous cells which have an appearance not unlike that of the plasma cells of connective tissue. Sometimes these cells are few in number, at other times they form a nearly continuous mosaic-like coating to the vessel wall for a considerable distance. They can be seen in various stages of formation, and fairly developed cells, stained with polychrome blue, show a deeply tinted blue nucleus and dark purple protoplasm which is often vacuolated and sometimes shows short processes. These cells appear to correspond to the "plasmazellen" described by Vogt in cases of general paralysis. In the cases included under Group I. these definitely formed "plasma cells" could not be found in relation with any of the vessels, even by the aid of the Unna-Pappenheim stain. Presumably the proliferative process in these cases was not seen at the stage at which these cells present their character-In experimental acute poisoning by ricin istic appearance. and abrin in animals, changes in and around the cerebral vessel walls could be seen to have occurred in a few hours in all respects similar to those found in the less affected vessels of the general paralytic's cortex, but up to several days no definite formation of "plasma cells" could be detected in the animal tissues.

In some cases granular deposits of hæmatoidin were seen in or near the vessel walls. Vascular extravasation, more or less extensive, were not infrequently found. Aneurismal or pseudo-aneurismal dilatations of the vessels were fairly common. Extensive thrombosis of the pial veins occurred in one case, and thrombosis to a less widespread extent in

another case. Darkly stained granules, by the Marchi method, were frequently seen in the perivascular spaces, in certain "carrier cells" and in the proliferating cells in and about the vessel walls.

The amount of congestion of the vessels varied much in the different cases. In those included under Group I. (moderate structural changes) there was more or less congestion of the cortical vessels, especially in the central area. As, however, there was comparatively little evidence of proliferative and degenerative changes in the vessel walls in these cases, it is probably fair to assume that this congestion was of recent origin, and that at no time had there been great circulatory disturbances. In some of the cases in Group II. the amount of vascular congestion was not very marked, although there were definite proliferative changes in the vessel walls. These latter might be regarded as evidence of bygone but perhaps fairly recent circulatory disturbance.

(III.) Morbid Histology of the Neuroglia, Migratory and other Cells.

(1) The Neuroglia.

My observations have been confined mostly to the cerebral neuroglia. The staining methods chiefly relied on have been:—(1) The Heidenhain iron hæmatoxylin method and slow counterstaining with erythrosin.¹ (2) Deep staining with polychrome blue after Nissl's method. The Heidenhain erythrosin method gives very clear pictures of the hypertrophied and proliferating neuroglia cells; the fibril formation is well seen and the cellular protoplasm generally well stained. Great care, however, is necessary in the

¹ Method of making the erythrosin stain (Bolton). Dissolve 75 grammes of erythrosin in a little dilute ammonia and make up to 80 cc. with distilled water, add dilute acetic acid and stir until a precipitate definitely begins to occur throughout. Make up to 100 cc. with distilled water and filter. This gives when filtered approximately a half per cent. solution of the stain. The solution should be kept slightly acid, otherwise it fails to act satisfactorily. Other preparations of erythrosin tried did not give good results.

differentiation of specimens. The polychrome blue method furnishes a good general idea of the neuroglia proliferation in its very early stages; the protoplasm of the young neuroglia cell is stained a peculiar purple colour which renders the cell readily recognisable even when its protoplasm is scanty. Other methods have also been used and the appearances compared with those seen in sections of the cortex prepared by the methods of Cox, Bevan Lewis, Ford Robertson (methyl violet method), and Ehrlich-Biondi.

In some of the cases examined the hypertrophy and hyperplasia of the neuroglia was slight, in some considerable, in others very great. With regard to situation it was scattered generally throughout the gray and white matter, but was invariably most advanced in the molecular layer of the cortex and was most abundant in the immediate neighbourhood of the vessels. The apparent relationship of the neuroglia proliferation to the vascular and neuronic changes will be discussed later.

Before detailing the appearances seen it would be as well to state that the description is limited to that of the neuroglia of epiblastic origin, and to those cells which are undoubtedly neuroglia cells, viz., those consisting of nuclei, with either definite protoplasm or fibrils, or both around them.

In the simplest form in which the cells are recognisable by the Heidenhain-erythrosin method they appear to consist generally of a fairly large nucleus of round, oval, or reniform shape, partially surrounding which is a small quantity of reddish-pink protoplasm. There is a well marked nuclear membrane, usually a large nucleolus at one side of the nucleus and a very delicate nuclear network, in the meshes of which are often seen numerous pink or darkly stained granules. In further developed cells the nucleus has much the same appearance but may be larger and clearer—the protoplasm is increased in amount and assumes various forms. The commonest forms seen are (1) a roughly conical or pyramidal cell with the large nucleus at the base. the nucleus is almost always very eccentric, appearing sometimes is if stuck on to the protoplasm and at other times as if having hardly any connection with the latter. The apex of the cell is unusually bifurcated and small slightly branching processes are seen coming from the sides of the cell. (2) A more or less spider like cell with numerous slightly branching processes. Frequently two nuclei and sometimes four or more are seen apparently enveloped by one mass of protoplasm. Often small cells are seen in little groups or chains as if they had but recently been divided.

A further stage seems to be that the protoplasmic outline and processes assume a more definite form, the borders of the protoplasm, or portions of it, and the tips of the processes are then often seen to be stained black by the hæmatoxylin, this being the first step towards the differentiation of the neuroglia fibrils. In still older cells the pink stained protoplasm is diminished in amount, the nucleus is smaller and more darkly stained, whilst the black stained fibrils are much longer and more evident. Later still the cells consist of a smaller, darkly stained nucleus, surrounding or partially surrounding which is a small quantity of pink protoplasm, from which spring a greater or lesser number of black fibrils. Some of the fibrils appear to recurve as they near the nucleus and others to bifurcate. In the latest stage no stained protoplasm, or very little, can be seen around the dark shrivelled nucleus, which is surrounded by numerous fibrils crossing and recrossing each other. Some fibrils appear to pass right across the nucleus above or below it.

Tracing the formation of the neuroglia fibrils thus, there can be little doubt that they are a condensation product of the neuroglia cell protoplasm, which is gradually used up in the process. That the fibrils become chemically distinct from the protoplasm can be readily seen by many methods, even in Marchi-iron-alum-Pal specimens, and those stained by the Stroebe method. The condensation seems to begin at the extremities of the protoplasmic processes and along the borders of the protoplasmic envelope, thus giving rise to the appearance of recurved and bifurcated fibrils so well seen in the neuroglia stained by Weigert's method. A somewhat similar account of the formation of the neuroglia fibrils has, if I mistake not, already been given by Ford Robertson,

Marinesco, and others. The process can certainly be very clearly traced in successful Heidenhain-erythrosin specimens. The fibrils are fine, medium, and coarse in thickness. The fine fibrils are the longest and most numerous. They are gently undulating as a rule, but occasionally very tortuous; they are more or less branched and usually smooth, but sometimes have little knob-like swellings in their course. The stout fibrils are fewer in number, shorter, and straighter, or run in bolder curves. Frequently a little pink stained protoplasm is seen along the course of some of the fibrils, and especially at the apparent place of division of a fibril into two or more branches.

With regard to the vascular attachment of the neuroglia, this appears to be so evident in preparations by so many different methods that there can be little doubt that it does occur. The attachment is seen in two forms: (1) By fibrils, which on nearing a vessel wall change their course if this is originally different to that of the vessel, then follow the vessel wall for some distance, and finally appear to become lost upon the latter. (2) By means of the so-called "foot" of attachment. This "foot" varies greatly in form; it is roughly triangular, but may be conical, "fan-shaped," flaskshaped, "bottle-shaped," or brush-like. Frequently this triangular attachment can be seen in young neuroglia cells in which little of the protoplasm has undergone differentiation into fibrils; this, I think, is its earliest form. A more advanced stage is shown by a thick, darkly staining fibril which, when approaching its triangular expansion, appears to divide into two branches (one usually thicker than the other), leaving between them and the vessel wall a mass of granular pink stained protoplasm. Frequently within this latter there are indications of the formation of fibrils, and many thick fibrils are seen which appear to divide into three or four or more branches before passing on to a vessel wall. I conclude that the protoplasm of the "foot" ultimately all becomes differentiated into fibrils, and that the brush-like termination represents the most highly developed form of attachment. Often two or more thick fibrils are seen passing from one cell to a vessel wall, or one thick and

several finer ones. Also fibrils from one cell may pass to two or more vessels; or, again, fibrils from a single cell may pass to a vessel wall, whilst others from the same cell surround a nerve-cell. In most of the older neuroglia cells of the molecular layer of the cortex stained by the Heidenhain-erythrosin method a small amount of pink stained protoplasm can be seen about the dark nucleus, connecting this with the fibrils; in others none can be detected. In the latter case the fibrils sometimes appear to "fall short" a considerable distance from the nucleus, and certainly appear to be morphologically separate from it. I feel some hesitation in believing that they really are so, however, because it is quite possible that the nucleus still retains around it some protoplasm which, being in a feebly metabolic state, does not stain by the method used, and that the fibrils are still in morphological union with such protoplasm. On the other hand, I consider that the method of Golgi and similar methods made use of by many who support the view that the neuroglia fibrils never become anatomically separate, are quite unreliable in this connection.

I have not observed signs of proliferation in the glia cells which have well marked fibrillar processes, although the younger cells frequently appeared to be dividing. Therefore I am inclined to think that proliferation of the neuroglia occurs chiefly through those cells the protoplasm of which has not undergone differentiation into fibrils to any extent, or, according to Eurich's view, through those older cells which have parted with their fibrils, if such separation actually does occur.

I have not seen any signs of pigmentary degeneration in the neuroglia cells in the cases of juvenile general paralysis examined.

The mesoglia.—Other cells, which are certainly not nerve-cells were observed in fair numbers in these cases, differing in appearance from those above described. Some have processes which are distinctly "feathery" in appearance; others are small cells with several short branching processes, none of which appear to form any vascular attachments. These latter may correspond to the

cells described by Ford Robertson under the name of "mesoglia" cells.

(2) The Migratory and other Cells.

Of the multitude of small round elements seen about the vessels, in the intervascular areas and around the degenerating nervous structures, many can be shown to be the nuclei of neuroglia cells. Others exist of a more doubtful nature. No protoplasm can be seen around them, and they frequently differ in appearance from the nuclei of those cells which are undoubtedly neuroglia cells. Some of such round cells would appear to be lymphocytes. From the general appearance of numbers of these nuclei and from their frequent somewhat linear arrangement it is at least not improbable that they represent portions of developing capillaries. Some of these elements, further, may be those described by Ford Robertson as "mesoglia" cells which have lost their processes and become branchless. In Marchi preparations many of these round cells in the pia, in the perivascular and perineuronal spaces, and in the intervascular areas, are seen to contain numerous darkly-stained particles, presumably the products of degeneration of the nervous elements. Such "carrier cells" (Ziegler) are observed in greatest abundance when the acute degenerative process is most extensive.

Often these round cell elements are seen massed in large numbers around the degenerating nerve-cells, although it must be admitted that the majority of these undoubtedly seem to be the nuclei of neuroglia cells. I have not been able to satisfy myself, however, that these small cell structures, of whatever nature, ever actually encroach upon the nerve-cell. Sometimes they may be observed lying in slight hollowings of the border of the cell, but such a situation may be accidental. More usually they are quite at the side of, or above, or below the cell. Many nerve-cells, moreover, are seen in very advanced stages of degeneration, with marked destruction of the cellular reticulum, but without any of these small cell elements whatever in their immediate neighbourhood.

SECTION D. MORBID HISTOLOGY OF THE DIFFERENT PARTS OF THE NERVOUS SYSTEM.

(1) The Cerebral Cortex.

The morbid histology of the cortical neurones has been referred to generally under Section C, as has also the condition of the vessels, the neuroglia, and other cells. In this section, as regards the cerebral cortex, it is proposed to deal chiefly with the relative degree of involvement of the different cortical areas, leaving the discussion of the relationship of these to the vascular and neuroglial changes mostly until later.

Cortical areas examined.—In one or other of the cases sections were taken from very many of the regions of the cortex, but the more systematic examination has been limited to the following areas, which have been investigated in the majority of the cases:—

(1) The central convolutions, particularly the upper portions of the ascending frontal. (2) That portion of the brain in front of the ascending frontal convolution, especially the prefrontal region and Broca's convolutions, although in several instances the posterior and other portions of the second and first frontal convolutions have been examined. When the prefrontal region is mentioned this may be understood to mean roughly the anterior two-thirds of the first and second frontal and the anterior third of the third frontal (3) Portions of the superior and inferior convolutions. parietal lobules. (4) Portions of the first and second temporal convolutions. (5) The occipital region—the area of the calcarine fissure chiefly, but including always portions of the "visuo-sensory" and "visuo-psychic" cortex. position of the blocks removed for microscopical examination was for future reference carefully marked out upon drawings of the cortex.

The nerve-cells.—As has been stated, two distinct types of degenerative changes were distinguishable in the cortical nerve-cells: the one a chronic type found in all the cases, the other a more acute type seen especially in those cases in which the congestion of the vessels was most marked.

The class of nerve-cells most frequently involved in the latter type of degeneration has already been mentioned.

With regard to the affection of the different cortical layers, the molecular layer relative to the other layers appeared to be increased in thickness in the regions most involved. The pyramidal layer of nerve-cells was always at least somewhat thinned excepting in parts of the occipital and central cortex in some instances. In the areas of the cortex most affected, this diminution of the pyramidal layer was extremely marked generally, in other areas it was chiefly noticeable on the flat surfaces of the convolutions. Of the nerve-cells the small pyramids were invariably the most involved by the degenerative processes; in many instances these cells were greatly reduced in number, whilst often the majority of those remaining were hardly recognisable as nerve-cells. The medium sized pyramids were next most degenerated, whilst frequently many of the larger pyramids and the Betz cells of the motor area remained comparatively unaffected. The degree of affection of the polymorphic layer was more difficult to estimate. On the whole the chronic degenerative changes appeared to be much less than in the small pyramids, although the acute changes were often marked in the cells of this layer.

In several cases, especially amongst the imbeciles of this series, the nerve-cells were extremely irregular in their arrangement, their apical processes pointing in all directions. Many of the cells in these cases also appeared to be imperfectly developed, although this was very difficult to make out with certainty, the condition of the cell so often being obscured by degenerative changes. It may be mentioned in this connection that nerve-cells were not infrequently seen containing two well-defined nuclei; even in Betz cells this was occasionally observed.

The nerve-fibres.—It has already been stated that whilst in several cases many of the radial nerve-fibres, and sometimes some of the interradial fibres showed signs of recent degeneration in all the areas examined; the number of recently degenerated fibres was usually greatest in the central and occipital regions. In the other cases the amount

of recent degeneration was slight and was confined either to the central and occipital cortex, or to the former, or was practically absent. With regard to the atrophy of the fibres, some evidence at least of this was found in all the regions examined, the atrophy affecting especially the upper layers of horizontal fibres, the superradial as much as, or more than, the tangential. In the regions most involved by the fibres atrophy the deeper interradial and radial fibres were also markedly degenerated.

The Order of Affection of the Cortical Areas.

This has been estimated from a study of the relative degree of thinning of the pyramidal layer of nerve-cells, and of the degenerative changes in these cells, as well as from a consideration of the amount of chronic atrophy and recent degeneration affecting the nerve-fibres. There is considerable difficulty in determining the extent of diminution of the pyramidal layer, and the amount of involvement of the nerve-cells in the different regions of the cortex in so many cases. A very large number of sections have to be examined, and the personal equation is probably a very important factor in the result. Micrometric measurements of the cortical layers and comparison with the normal in different regions would, perhaps, give the best results, but even such measurements are not very satisfactory as regards the cortex of the general paralytic, and would involve enormous labour. The amount of nerve-fibre destruction is, on the whole, more easy of estimation than is the amount of nerve-cell degeneration; and, apart altogether from the question as to whether the nerve-cells or the nervefibres are the earlier involved in the degenerative process, the extent of atrophy of the latter is of distinct value when endeavouring to compute the relative degree of affection of the different regions of the cortex. The study of the nervefibre degeneration in these cases fully confirms the conclusions arrived at as to the degree of affection of the different areas from the nerve-cell point of view. Whilst admitting all the possible fallacies from both the nerve-cell and the nerve-fibre side it can be confidently asserted that the

variations in the different cortical realms were, generally speaking, of so gross a character that these latter can be placed in a certain fairly definite order as regards degree of relative involvement. The prefrontal region was invariably the most affected both with reference to the thinning of the pyramidal layer, the paucity of the nerve-cells and the extreme degree of degeneration of those remaining; and also as regards the apparent total destruction of practically all the horizontal system of nerve-fibres with marked chronic degeneration of the radial nerve-fibres. Further, in this area, in all the cases in which it was examined, essentially the same amount and degree of degeneration was found, it being extremely difficult in this respect to distinguish one case from another.

The parietal lobules and upper temporal regions were generally the next most involved. Considerable variation, however, occurred in the individual cases; sometimes one of these areas was more affected than the other, but seldom did either show a degree of chronic degeneration of the neurones equal to that seen in the prefrontal region. Broca's convolutions were sometimes affected to about the same extent as the parietal and temporal areas, but were usually considerably less so. Left Broca's convolution was generally, but not always, more affected than the right. The central convolutions in every case showed a less degree of general thinning of the pyramidal layer, of chronic degeneration of the nerve-cells, and of atrophy of the nervefibres, than did the prefrontal, parietal and temporal regions. In some cases a remarkable persistence of the horizontal systems of nerve-fibres, including the tangential and superradial, could be shown in the central convolutions by the method used; and in several instances where marked atrophy of these fibres had occurred this atrophy was patchy in character, involving chiefly a portion of a gyrus. The posterior parts of the second and first frontal convolutions were not so frequently examined as was Broca's convolutions, but so far as observed it may be said that the hinder portion of the second frontal was affected about equally with Broca's convolution, and the corresponding

part of the first frontal rather less so, but more than was the ascending frontal. The occipital region was invariably more or less affected, but the changes were mostly of more recent origin than those in other parts of cortex, excepting perhaps in some cases the central convolutions. In the occipital cortex the nerve-fibres were often comparatively little affected, at any rate in portions of the gyri. The terminations of the radii could sometimes be traced almost into the molecular layer, whilst the horizontal system of fibres remained in abundance and showed only early When pronounced atrophy of the atrophic changes. fibres did occur this was usually of a very patchy character. In some cases the occipital cortex was considerably affected, but in these the other areas were always more so. The relative order of involvement of the different cortical areas examined may, then, be briefly summarised as follows:--

- (1) The prefrontal most.
- (2) The superior and inferior parietal lobules and upper temporal next most.
- (3) Broca's convolutions, with perhaps the posterior portion of the second frontal, variable but usually less than (2).
- (4) The central convolutions, particularly the posterior central.
 - (5) The occipital.

It will thus be seen that practically the portions of the cortex most involved were the association areas of Flechsig, and next most the parts of the sensori-motor areas concerned in verbal and perhaps in written speech. With regard to the central convolutions, the anterior was invariably examined, the posterior in a few cases only. So far as could be judged, the changes in the posterior central usually appeared to be more advanced and of longer standing than in the anterior. This order of affection is practically constant, with slight individual variations, and can be seen in the whole of the seven cases, in which sections of these areas are available for comparison. In the other cases in which only some of these regions have been examined, the same order holds good with regard to those regions. The

relative degree of affection of the different areas is most easy of demonstration in those cases in which the signs of vascular disturbance are comparatively slight. In the cases which present signs of gross vascular disturbance, there is a tendency for the cortical areas to appear at first sight more equally involved. But in those cases in which the changes in the central and occipital cortex are so intense as to apparently bring these regions almost into line with the others as regards degree of involvement, there is evidence that the changes in the former are largely of more recent origin.

It should be again distinctly stated that only the abovenamed regions of the cerebral cortex were systematically examined microscopically, and necessarily only portions of these areas. Hence the conclusions as to the parts of the cortex most affected apply only in a somewhat limited sense. A considerably larger part of the cortex, however, was examined than might at first appear, because often two, three, or more blocks were taken from the neighbourhood of the parts named. In all some 250 blocks of the cerebral cortex alone were examined microscopically.

That the above-mentioned were the regions of the cortex most affected, is confirmed to some extent by finding these to be the areas in which there was most macroscopic wasting, where this could be accurately ascertained in the few cases in which one or other hemisphere was stripped. In the other cases the wasting could be seen in a general way to involve most the areas named.

Further, it is interesting to note that the results I have arrived at with regard to the cortical areas most affected by the disease, agree almost entirely with those obtained by Dr. Bolton, with reference to the regions of wasting of the cerebral cortex in mental diseases generally, including dementia paralytica, although the conclusions I have come to were formed from work done upon entirely different lines to those followed by Dr. Bolton.

The occipital region may be briefly referred to specially. The occipital cortex, as has been mentioned, did not escape in any instance, but on the whole was less affected than the other areas examined, especially by the chronic degenerative

changes. In the cases with optic atrophy the line of Gennari was found to be thinned in two cases, whereas in the other two this layer was not obviously altered. Possibly in the latter cases the optic atrophy was not of sufficient duration to have affected the terminals of the optic radiations in the calcarine area.

The Tapetum and the Fasciculus Longitudinalis Inferior.

Whilst endeavouring to trace by the Marchi method recent degeneration of the fibres of the optic radiations in the calcarine region in certain of the cases with optic atrophy, very large sections of this region were made. These included the whole depth of the calcarine fissure cut as nearly transversely as possible, the neighbouring gyri and a considerable portion of the white matter below the fissure and surrounding the posterior horn of the lateral ventricle (or behind this). Many of the radial fibres showed recent degeneration, as did others of the short association fibres connecting the different occipital gyri. Some fibres, which from their position appeared to belong to the optic radiations, were also affected. Besides these, however, a number of fibres showed recent degeneration—sometimes a very large number—which from their position and direction were concluded to be part of the bundles of long association fibres connecting the occipital lobe with the frontal and temporal lobes respectively, viz., the tapetum and the fasciculus longitudinalis inferior. In other cases similar preparations were made, and in all these systems of long association fibres were found to be involved.

The Efferent Tracts.

That some of the radial fibres in the sensori-motor cortex which showed recent degeneration are undoubtedly the axones of motor cortical nerve-cells, which at some relatively recent period had undergone destruction, is evident. Fibres in the position of the efferent tracts, and showing recent degeneration, were traced in two instances completely through the internal capsule, the crus, pons, medulla, and

by the direct and crossed pyramidal tracts to the lower levels of the spinal cord. In several other cases these fibres were followed in the same situations, excepting through the internal capsule. In some instances the recent degeneration was practically limited to the efferent tracts, neighbouring systems of fibres being but very slightly affected.

The Basal Ganglia and Internal Capsule.

These structures were only investigated in two cases, in one of which a fairly complete examination was made.

The changes in the lenticular nucleus and in the optic thalamus were very marked, especially in the latter. The nerve-cell degeneration was of the acute and chronic forms, and in many of the nerve-cells the degeneration was very advanced. A striking feature was the amount of brownishyellow pigment contained in the cells, much more than in the cortical nerve-cells. In some of the degenerated cells the normal structure was almost entirely replaced by pigment. Recent changes by the Marchi method were found in a few bundles of fine nerve-fibres scattered throughout the optic thalamus. Congestion of the vessels was extreme; their walls were much thickened, and there was marked neuroglia proliferation. The fibres of the internal capsule showed scattered degeneration throughout, the fibres of the motor system and the fronto-thalamic and fronto-cerebellar fibres were distinctly affected in both cases. A definite tract of fibres showing recent degeneration in one case, which was traced downwards into the crus and pons, and which appeared to be part of the caudate cerebellar system of fibres, will be more fully referred to in the description of the pathological histology of this case (vide Case 8, p. 710).

The Cerebellum.

This was examined in the majority of the cases, sections being made of the superior or lateral portions of the hemispheres, and in some cases of the dentate nucleus also.

The changes generally were less marked than in the cerebrum, but were sufficiently obvious to enable one to assert that the cerebellum did not escape. There was

decided thickening and congestion of the membranes and of the vessels generally. The molecular layer of the cerebellar cortex was usually diminished in thickness, and there was frequently decided paucity of the Purkinje cells, many of which showed various stages of degeneration. No pigment, however, was found even in the most grossly degenerated The cells of the dentate nucleus were found to be greatly altered in two cases, many of the cells being swollen and vacuolated. In these cases recent degeneration of the nerve-fibres entering or leaving the dentate nucleus was noticed by the Marchi method. In several cases recent degeneration of the projection fibres and of the short association fibres of the cerebellar cortex was found, whilst considerable atrophy of the horizontal fibres was shown in most instances by the Marchi-iron-alum-Pal method. The neuroglia proliferation was in no case pronounced.

The Crura Cerebri, the Pons, and the Medulla.

Portions of these structures were examined in ten of the cases, and in some a fairly complete examination was made.

The nerve-cells, as shown by the Nissl method or one of its modifications, were not nearly so markedly affected generally as were the nerve-cells of the cerebral cortex in the same cases. Special attention was paid to the cells of the cranial nerve nuclei. In many instances these showed very slight departure from the normal. In some, various stages of acute and chronic degeneration were seen—seldom advanced, however. With regard to the cells of the motor cranial nerve nuclei, on the whole they might be said to be affected to about the same degree (or rather less) as were the Betz cells of the cerebral cortex in the same cases.

The cells of the posterior column nuclei in the medulla were, as a rule, only little affected, but in some instances these cells showed marked acute destructive change. There was no pronounced alteration in the cells of the olivary bodies. Pigmentation of the degenerating cells was usually distinctly greater than in the cortex cerebri, but was not as a rule very marked. The vessels were often very congested,

but the cell proliferation about the vessel walls was, on the whole, less pronounced than in the cerebral cortex. The neuroglia proliferation was, however, sometimes considerable.

By the Marchi method recent degeneration of the nervefibres was found in the efferent pyramidal bundles in every case; in some instances only a few fibres were affected, in others a very large number. The latter were invariably the cases in which acute degenerative nerve-cell changes were most marked and extensive in cerebral motor cortex, and in which many of the radial nerve-fibres in this region showed recent degeneration.

In some cases well marked recent degeneration was found in the fibres of the superior and middle peduncles of the cerebellum. In one case especially, in which the cells of the dentate nucleus of the cerebellum were swollen and vacuolated, the nerve-fibres entering or leaving this nucleus, together with those of the superior cerebellar peduncles, including those of the decussation of the latter in the pons, were found by the Marchi method to be distinctly degenerated.

Some fibres apparently of the caudate cerebellar system, which showed recent degeneration in one case, have already been referred to.

In the crura cerebri recent degeneration was seen in some instances of fibres in the position of the fronto-cerebellar and temporo-occipital cerebellar systems.

Scattered recent degeneration was found elsewhere in the fibres of the pons and medulla, especially in the restiform bodies and posterior columns. The afferent tracts were, however, not so definitely and extensively affected as were the efferent.

No definite recent change was found, except in one or two instances by the Marchi method, in any of the cranial nerves in their intrapontine or intramedullary course. In some cases, however, black stained droplets were seen along the course of the nerve which might be mistaken for such. Careful examination, however, showed that these droplets were outside the myelin sheath, in the lymphatic spaces,

and were probably the result of recent degeneration elsewhere. Stained by van Gieson's method no change was found in the axis cylinders of these fibres.

The Spinal Cord.

This was examined in eight of the cases.

The Nerve-Cells.

The anterior horn cells on the whole were not grossly affected. In every case many cells could be found which were practically normal. Others presented various stages of chronic and in some instances of acute degeneration, in some the changes being advanced. Vacuolation of the cells was rarely seen. The cells, especially in the lower levels of the cord, contained much more pigment (yellow in Nissl and brownish-black in Marchi preparations) than did the large cells of the cerebral cortex in the same cases. As in the instance of the cells of the motor cranial nerve nuclei the changes in the anterior cornual cells might be said to be on about a par with those in the Betz cells of the Rolandic cortex in the same cases.

The cells of Clarke's column sometimes showed distinct atrophic changes in some instances, but as a rule, and taking into consideration the normal appearance of these cells as recently described, they presented little alteration.

The Nerve-Fibres and Tracts.

Antero-Lateral Columns.—The pyramidal tracts, direct and crossed, were affected in every case, this being the only constant tract lesion found in the spinal cord. By the Marchi method at least a few fibres belonging to these tracts were always seen in a state of recent degeneration, and in several instances such fibres were numerous. Especially was this so in the cases which showed extensive acute degeneration of the cortical motor cells. As has been mentioned, in two cases efferent projection fibres showing recent degeneration were traced fairly completely through the internal capsule, the crura and pons to the motor decussation, in the

medulla, and thence to the spinal cord. In several other instances they were followed in the same situation excepting through the internal capsule. Hence I think there can be little doubt that such change in the fibres of the pyramidal tracts is a true secondary descending degeneration, the result of the destruction of the motor cells in the Rolandic cortex. Fürstner, however, places this as the least frequent of the spinal cord changes in general paralysis.

In some cases the recent degeneration was practically restricted to the fibres of the pyramidal tracts, but in other cases scattered fibres were affected in the remainder of the antero-lateral columns not limited to any particular tract, some possibly being aberrant fibres of the pyramidal tracts, and others possibly fibres primarily affected. In a few instances the fibres of the anterior commissure and of the anterior roots showed some recent degeneration. Sclerosis of the pyramidal tracts was found in every case, occasionally slight, but generally fairly well marked. The sclerosis was most definite in the crossed tracts and as a rule in the lateral columns was sharply restricted to these tracts.

Posterior columns.—Recent degeneration of scattered fibres was found in several cases, the endogenous fibres being affected almost equally with the exogenous. In other cases practically no recent degeneration was seen in the fibres of the posterior columns. In four cases either no sclerosis was found in the posterior columns or the sclerosis was slight and indefinite in character. In the remaining four cases there was distinct sclerosis, and in these the lesions were definite in arrangement, symmetrical and limited to the exogenous fibres. Some of the posterior roots, so far as examined near their union with the cord, were affected in these latter cases and in these only. In these cases, also, some of the anterior roots were sclerosed, but the affection of the anterior roots was not so severe and extensive as that of the posterior.

The membranes were invariably thickened, often greatly so. The vessels were frequently congested. In some cases there was not any marked structural changes in their walls. In other cases, however, practically as much structural

change was found in the vessels of the cord as in those of the cerebral cortex. The neuroglia proliferation was usually considerable, especially in the most degenerated areas.

The Posterior Root Ganglia.

No great amount of attention has been paid by the writer to these structures, partly from lack of time, and partly because he is in agreement with those who maintain that very special methods of fixation, &c., are necessary in order to accurately reveal the finer changes in the ganglion cells. These precautions were not adopted in the earlier cases, and in the cases obtained later the opportunity of carrying them out has not arisen. In some instances, however, fairly satisfactory preparations were obtained. So far as could be made out there was no great change in the nerve-cells. alteration appeared to be hyper-pigmentation, but in some cases, however, even this did not occur, and the cells were practically healthy. In other cases a few of the cells, especially the smaller ones, appeared to be considerably degenerated, and there was evidence of proliferation of the elements of their surrounding capsule.

The Optic Nerves and Optic Tracts.

Marked atrophy of both optic nerves was present in four out of the twelve cases. The optic nerves were extremely shrivelled, appearing to consist mostly of connective tissue, and of proliferated and hypertrophied neuroglia; at least many of the cells seen had exactly the same characters as those of cortical neuroglia. In some instances very few nerve-fibres could be made out, in others a considerable number of fine fibres had persisted. No recent degeneration of the fibres was found by the Marchi method, excepting in one case.

In Case 8 a very large number of sections were made of one optic tract, and of the primary optic ganglia, stained by the method of Marchi. No recent degeneration of fibres was found in the body of the tract, nor in the fibres in the neighbourhood of the lateral geniculate, the pulvinar, or the corpus quadrigeminum anterior. There appeared to be con-

siderable atrophy of these fibres, however, in sections stained by the Marchi-Pal method. In this case Marchi degeneration was apparent in the fibres of the internal capsule in the position of the optic fibres, also in some of the fibres around the posterior horn of the lateral ventricle (optic radiations), and in some of the radial fibres of the calcarine cortex. There was, moreover, some general thinning of the line of Gennari in this case.

PART II.

GENERAL REMARKS ON THE ETIOLOGY AND PATHOLOGY OF THE DISEASE.

From the study of the cases included in this series the chief factors concerned in the genesis of juvenile general paralysis would appear to be heredity and syphilis, both probably being essential. The writer's own clinical experience accords with this conclusion. Under hereditary factors are placed insanity and its allied disorders, together with such devitalising agents as syphilis, phthisis and alcohol. The influence of syphilis may thus have to be taken into account twice; first, as a truly inherited influence—a devitalising one on the parents, of a similar nature to that exerted by phthisis and alcohol, and again as a factor which should perhaps, strictly speaking, be termed transmitted or acquired. The prevalence of the above-named diseases in the ancestry of the victims of juvenile general paralysis is strikingly illustrated in the family histories of several of the patients in this series.

The presumption is that the individual with such ancestry is liable to be an imbecile or become a lunatic, but that if he himself is free from the syphilitic taint he will not become a general paralytic. It may be suggested that in such a case only the relatively higher neurones will be involved, whilst those which subserve lower functions will escape. If, however, the syphilitic poison is added (through infection either during fœtal life, or at or shortly after birth), the latter causes vascular and interstitial changes which enlarge the

area and hasten the progress of the neurone degeneration. Such a case would then assume the clinical features of general paralysis, as shown essentially by further and progressive dementia and paresis.

The direct effect upon the individual of alcohol and other poisons, and of those conditions which may be included under the general term of "stress," are probably of great importance in the adult in determining the period of onset of the disease, and perhaps its point of attack, as well as in hastening its progress. With the exception of the stress associated with the periods of puberty and adolescence, these conditions may be excluded in many cases of the juvenile form of the disease. On the whole the juvenile may be said to represent a purer type of the disease than does the adult, and in the former these subsidiary factors cannot be regarded as playing an essential part in the genesis of the disease.

The disease in its later stages is now usually admitted to be a widespread one involving practically the whole of the nervous system, and certainly many of the non-nervous organs. A considerable number of the morbid appearances met with are, however, the direct or indirect result of syphilis, e.g., the fibrosis of the organs and many of the more chronic vascular changes, whilst others are the direct or indirect result of gross vascular disturbances. Many of both these sets of manifestations may or may not occur in general paralysis, per se. The widespread nature of the affection is evidenced by the examination of the cases included in this series, in which very many parts of the nervous system are seen to be involved. Taking the cerebral cortex alone, however, sections have been made from a great many cortical areas, and all of these were found affected. I am thus unable to agree with Starlinger and others who maintain that the disease is virtually limited to the motor con-Even in the adult form of the disease, according to my experience, not only is the affection not confined to the motor cortex, but that portion of the brain is not the one usually most involved.

Whilst admitting, then, that the disease in its later stages is a widespread one, the writer thinks there is evidence to

show that, apart from those phenomena which are the result of syphilis, or of gross vascular disturbances, the disease does not tend to affect the motor, sensory, and association neurones indiscriminately, but involves these in a certain definite order which corresponds very closely with that of their development and relative functional value. With the above reservations the cerebral cortical neurones are the first and most affected, but these are not involved indiscriminately as witnessed by the comparative degree of affection of the various cortical areas, and of the elements comprising the different cortical layers.

- (1) The cortical areas.—From the work so far done, the writer has placed the cortical areas in the following order as regards relative degree of involvement (see p. 653):—
- (a) The association centres of Flechsig are most affected; the anterior centre practically always more than the parietal and temporal portions of the posterior centre.
- (b) Broca's convolutions, with perhaps the posterior portion of the second frontal convolution. These, however, are sometimes as much involved as the parietal and temporal areas.
- (c) The central convolutions, the posterior usually more than the anterior.
 - (d) The occipital region.

Thus whilst the sensori motor area as a whole tends to escape comparatively until a relatively late period of the disease, the portions of this area concerned in verbal, and perhaps in written speech, become earlier affected. It may be objected that in those of the juvenile patients who were imbeciles one would expect to find a considerable amount of affection of the higher functioning association centres. A similar "selection" of the degenerative process was, however, found also in those patients who, previous to the onset of the disease, were possessed of average intelligence. Moreover, the change seen in all the cases is not a mere arrest of development but actual and gross degeneration of the nervous structures.

(2) The elements composing the cortical layers. Of the nerve-cells, the pyramidal layer, the last to be developed, is

always the most affected, and of the elements forming this layer the smaller cells practically invariably exhibit more degeneration, especially of the chronic type, than do the larger cells and the Betz cells of the motor cortex. These latter cells, with those of the polymorphic layer, tend to escape relatively until a comparatively late period of the disease. Of the nerve-fibres, the later developed upper horizontal system, the tangential and superradial, especially the latter, and particularly the coarse fibres belonging to the "secondary set" in these systems, degenerate before the earlier developed deeper horizontal fibres and those belonging to the radial systems.

In the writer's opinion the essential feature of the disease, from the side of its pathological histology, is a primary progressive decay of the neurone itself owing to its defective durability. Such decay of the neurone is not proportional to the amount of structural change found in the vessel walls, and indeed in certain cases it occurs to a great and widespread extent without evidence of gross vascular degeneration. In all cases of the disease, however, there is more or less marked evidence of vascular disease and of proliferative changes in and about the vessel walls, which would tend towards the more rapid destruction of the neurone and towards the involvement of larger areas in such destruction. Besides this chronic degeneration of the neurone most cases show in addition evidence of acute or sub-acute destructive processes affecting large numbers of neurones, but especially those of the central cortex, and to a less extent those of the occipital region. The latter changes would appear to be largely due to circulatory disturbances, and although they may be widespread to especially involve the areas mentioned.

Before considering the relationship between the vascular changes and the neurone destruction, the chief factors which appear to lead to vascular degeneration, to proliferative, vascular and neuroglial changes, and to circulatory disturbances, may be briefly dealt with. There is no doubt that extraordinary variability exists in these conditions in different cases and in different types of general paralysis,

and it is probable that several factors play a part in their causation.

- (1) The age of the patient. It is to be remembered that the adult general paralytic has had his vessels subjected to say some twenty years' more "wear and tear" than has the juvenile, and in him one would expect to find the more evidence of vascular degeneration, as is actually the case.
- (2) The direct effect of such conditions as "stress" of occupation or mode of living; of various poisons such as alcohol, nicotine, lead, mercury, the specific fevers and others. Occasionally, even in the juvenile, the effects of one or more of such factors have to be taken into account, although usually they can be mostly excluded.
- (3) Syphilis (a). This would appear to produce changes especially involving the arterioles and capillaries. changes, however, when the case has arrived at the stage in which it is diagnosed as general paralysis, are partly, if not wholly, of the nature of residua, the syphilitic poison having probably long ceased to act directly. The alterations in the vessel walls then found, particularly the hyaline degeneration, are evidences of a reaction to a long past injury. The amount of vascular degeneration thus produced may depend upon the dose and virulence of the syphilitic poison, hence its variability even in the juvenile cases. (b) Some of the vascular changes, especially the more active proliferation of the elements of the vessels walls, as well as much of the neuroglia proliferation, is the natural result of a more recent reaction to an injury. The neurone lesion being at first primary the vascular and interstitial proliferation is an effort at repair, which effort, as so frequently occurs elsewhere, may overstep beneficial limits, may extend beyond the original seat of the lesion, and in the end do more harm than good. That this proliferation is so often excessive, is probably another condition for which syphilis is in some degree responsible, the tendency to over proliferation in reply to an injury being a characteristic feature of this disease. The evidence of this reaction varies very much in the individual cases. In those which exhibit practically only a chronic atrophic process affecting the

neurones it is comparatively slight. In such cases the degeneration of the nervous structures being slow, the proliferation about the vessels and the glial replacement is gradual also, and may not occur to any great extent before the death of the patient. On the other hand in those cases in which the neurone destruction has taken a more rapid form, there is invariably great congestion of vessels, much proliferation of the elements of the vessel walls and of the neuroglia. This reaction may well be both effect and cause of neuronic degeneration in such cases; the one factor acting and reacting upon the other, the area of degeneration will thus gradually tend to become enlarged.

- (4) Some of the irritative and congestive phenomena may be due to the accumulation in the blood of the products of degeneration and of deranged metabolism of the neurones, as is so strongly insisted on by Mott. The objections that have been raised to this on the grounds that experimental secondary degenerations of these structures are not attended nor followed by irritation of the neighbouring vessels and by glia proliferation, cannot, I think, at the present time be maintained. The fact that evidences of such irritation and proliferation may be less in the experimental lesion than it usually is in the general paralytic is readily explainable on grounds which need not be detailed here. It is probable that this factor operates very variably in individual cases. In those in which the destruction of the neurone is mostly of a gradual character, the products of degeneration being formed slowly, are most likely capable of being largely removed by the ordinary channels, and therefore do not accumulate to any extent in the blood. In such cases one of the probable causes of secondary irritative vascular and other changes and of venous stasis acts relatively little, at least until a late period of the disease.
- (5) Some of the vascular changes may be the result of a general toxemia, apart from that due to the accumulation of degeneration products. This, however, I take it is only one of the complicating conditions which usually arise in the course of this as in the course of many other diseases.

With regard to the relationship between the vascular

changes and the neurone degeneration, taking the cerebral cortex alone, it may be said in the first place that although the amount of structural disease in the vessel walls varied greatly in the individual cases, yet all the cases exhibited practically the same degree of atrophy of the nerve-cells and nerve-fibres in the regions most affected, especially in the prefrontal region. This comparison is all the more useful because all the cases had virtually reached the final stage of the disease. The areas in which the amount of destruction of the nervous elements showed most variation were the central, and, to a less extent, the occipital region, and it would appear that the amount of degeneration in these regions was, to a considerable extent, dependent upon the intensity of the congestive process, and consequent more acute destruction of the neurone, which existed in any given case. In the cases which showed only moderate vascular congestion practically only chronic atrophic changes were seen in the nerve-cells, and little evidence of recent degeneration in the nerve-fibres. When the nerve-cells did show acute changes these were usually early, amounting only to some swelling of the cell and chromatolysis. If the patient had lived longer and the congestive condition had persisted, probably the changes in these cells would have gone on to complete destruction. It was in those cases in which the congestion of the vessels was very marked, and in which there was evidence of very active proliferation of the elements of the vessel walls and of the surrounding neuroglia that the most evident acute destructive changes were found in the nerve-cells, and the most extensive recent degeneration in the nerve-fibres.

In considering the relationship between the vascular changes and the degeneration of the neurone, I think some confusion has arisen from the apparent failure on the part of many to sufficiently appreciate the time element involved, and to distinguish with sufficient clearness acute and chronic processes as regards both vessel and neurone. I would summarise my own observations with regard to the matter in the statement that in general paralysis the *chronic* degenerative changes affecting the

neurone are not proportional to the amount of chronic structural change in the vessel walls, whilst the acute changes are proportional to the amount of vascular congestion, and of active proliferation of the elements, in and about the vessel walls.

Many instances can be cited in which there is a want of proportion between structural vascular changes and neurone degeneration, e.g., senility, cerebral syphilis, and those diseases in which a generalised arterio-capillary fibrosis occurs, and yet in which the neurones may, and frequently do, remain practically unaffected. Provided that the specific durability of the neurone is of the normal standard it appears to be capable of maintaining its existence virtually intact for a long time, in spite of circulatory and nutritional difficulties, but if its specific durability is below the normal, or if it is already affected by some degree of degeneration, it is more readily susceptible to such difficulties. It would seem also that the neurones are more readily affected by sudden alterations in their nutritional environment, such as those caused by venous stasis, than by the more slowly produced alterations represented by chronic changes in the vessel walls. Such chronic structural changes, however, no doubt must ultimately affect neurones, either liable to degeneration, or already to some extent damaged. This, together with the more acute effects produced by comparatively sudden alterations in the circulatory conditions which occur, especially in the later stages of the disease, accounts probably for the final involvement of the lower neurones.

Although some degree of vascular degeneration may be necessary before the neuronic breakdown occurs, the essential point appears to be that such a degree of vascular degeneration would have practically no effect upon neurones of normal durability, or upon neurones not to some extent previously damaged. In this respect then, a defective durability of the neurone, however produced, seems to be the essential and virtually primary factor in the genesis of the disease, general paralysis. In these cases of the disease in which the vascular lesion is comparatively

slight, it is presumable that the inherited insufficiency of the neurone is great, and the fact that less vascular degenerative and congestive changes frequently occur in the juvenile, would point to the latter as representing the purer type of neuronic breakdown. Such a problem as this, together with others, such as that of the relative degree of involvement of the different cortical areas, is not, I think, so likely to be satisfactorily elucidated by the study of many of the socalled early adult cases of asylums, as by the investigation of a large number of cases of the juvenile form of the disease. In the adult, in addition to the extreme difficulty of certainty of early diagnosis in many cases, complicating factors (to say nothing of the age of the patient as compared with the juvenile) frequently arise, such as the effects of alcoholic and other poisons which tend to produce gross vascular changes, and to give enormous variety to the clinical and pathological picture. Even in many cases of the juvenile variety, very marked vascular changes occur, and too definite conclusions cannot be drawn from the examination of one or two cases only.

The relationship between the overgrowth of the neuroglia and the neurone degeneration, as seen in these cases, has already been touched upon, but may be again briefly referred The one factor upon which the neuroglia proliferation appears to depend is that it is part of a reaction to an injury, and an attempt at replacement. If the destruction of the neurone is of a slow and gradual nature the reaction may be slight, and the neuroglia replacement occur slowly also. however, the degeneration of the neurone is of a more acute character, the reaction and attempt at repair is rapid, and may be excessive. In the latter event, considerable overgrowth of the neuroglia may occur, even before there is any very great or widespread destruction of the neurones. In fact, by encroaching upon the latter, and perhaps by depriving them of a certain amount or quality of nourishment, the over developed neuroglia may assist in the destruction of the nervous elements. This occurs probably more especially in the outer layer of the cerebral cortex, where the neuroglia proliferation and fibril formation is always the greatest. I

cannot, however, agree with the statement so often made, that when the neuroglia is developed to a marked degree in the outer layer of the cortex, the tangential nerve-fibres will have disappeared. Frequently such tangential fibres can be shown to exist with marked neuroglia development, although the nerve-fibres have then usually a curled and broken appearance. In all cases where the neuroglia showed marked evidence of recent activity there was great vascular congestion, and the amount of such activity was always fairly proportional to the degree of this congestion. The rapid neuroglia proliferation appears to be largely dependent upon the vascular condition of the tissues and it may be due to some extent to the same irritants which are supposed to assist in bringing about venous stasis, and to some extent to the increased nutrition from continued dilatation of the vessels and heightened arterial tension. There is certainly known to be a close relationship between continued venous congestion, and increase of connective tissue in other parts of the body.

I am unable to subscribe without some modification to the general statement that the amount of neuroglia hypertrophy and hyperplasia is an index of the extent of the degeneration affecting the nervous elements. On the one hand the absence or slight amount of neuroglia fibrillation does not necessarily indicate that the destruction of the nervous elements is small in amount, because in a slowgoing case there may be little active neuroglia proliferation, fibrillation may take a very long time to develop and may not have occurred to a marked extent before the death of the patient. On the other hand, in certain cases the active development of the neuroglia seems to exceed proportionately the destruction of the neurone. Still, on the whole, this active proliferation of the neuroglia appears to afford some index of the extent of the acute destructive changes which are affecting or have affected the neurones. processes are usually in reasonable proportion to each other, and to the amount of vascular disturbance.

Modes of removal of the degeneration products.—No evidence has been found in the examination of these cases

to warrant the conclusion that the ordinary neuroglia cells act in any sense as special phagocytes, although possibly the elements described by Ford Robertson as "mesoglia" may do so.

The products of degeneration in the nervous system would appear to be removed in much the same manner as are such products in other parts of the body: (1) by the ordinary lymph channels; if the degeneration is not very widespread or very acute this mode of removal may be practically sufficient and probably is so in the earlier stages of the disease; (2) by means of "carrier" cells of whatever origin attracted to the area of degeneration and acting as elsewhere in the body; (3) by means of certain fixed cells of mesodermal origin, e.g., the vascular endothelium. Certainly many of the endothelial-like cells in and about the vessel walls contain darkly stained particles in Marchi preparations when the degeneration of the nervous elements is acute in character. This appearance may to some extent be due to fatty degeneration occurring in the endothelial cells, but I think cannot be wholly so accounted for. It is always most marked where there is most evidence of acute destruction affecting the neurones.

Other points of interest in the pathological histology of the disease cannot be dealt with here. Many are fully referred to under separate headings and in the account of the individual cases.

As this paper is an endeavour at description, more particularly of the writer's own findings, and an exposition of his own conclusions rather than any attempt at criticism of the views of others, little reference has been made to the work of previous writers. Most of the publications incidentally mentioned are given below.

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PART III.

Notes of the Twelve Cases.

CASES 1 to 7 have not previously been recorded. Of the remaining five cases clinical accounts up to certain periods have already been published by Dr. Mott in vol. i. of the Archives. From considerations of space the notes have been condensed as much as possible.

Case 1.

M. T., female. Age, at the onset of the disease, 14 years; at death, 23 years.

Family history (from the mother).—Parents married at the ages of 28 (F.) and 23 (M.). Father was alcoholic and died of general paralysis. Mother has marked tertiary syphilitic sores. There was phthisis on the mother's side (grandfather, uncle and aunt). Patient was the eldest child, born three years after marriage. The next pregnancy resulted in miscarriage at three months. The next and last child is healthy.

History and course.—Patient was born at full term after an easy labour; was always a dull and simple child, backward at school. At 14 years of age got a severe fright, and after this she became "very queer;" would wander aimlessly about and lose herself. She gradually became more stupid and was sent to Cane Hill Asylum in December, 1895.

On admission was well nourished and showed no evidence of organic disorder; signs of inherited syphilis not noted. She had a fatuous appearance and was very childish; unable to converse sensibly, or even to give her age or any particulars about herself. She was restless, troublesome and dirty in habits. In 1896, 1897 and 1898, excepting that her behaviour and habits were rather better, there was no change in her condition. Towards the end of 1899 she had become more demented and wet and dirty in habits. She also then showed distinct signs of general paralysis. Pupils dilated and sluggish; much tremor of lips and tongue; speech slurred and hesitating; gait feeble and unsteady; knee-jerks and superficial reflexes very exaggerated. In May, 1900, she had some rise of temperature and twitchings of the right hand. In June she began to have difficulty in swallowing; the pupils were then widely dilated and fixed. In October and November had a series of "seizures" affecting the right side; was afterwards unable to speak at all, and was very stiff and resistive. She became rapidly more feeble and helpless and died on December 2, 1900.

Post-mortem Examination.

December 3, 1900.—Body emaciated; limbs contracted; no bedsores.

Skull cap thickened and dense. Dura thick and adherent to skull cap. Pia-arachnoid thickened and opaque generally over the vertex, especially in the fronto-parietal and upper temporal regions. Hemispheres very adherent anteriorly. There are small hæmorrhages in the pia-arachnoid over the middle of the first and third left frontal convolutions. The membranes strip fairly readily where stripping was attempted.

The Brain is small. Convolutions somewhat simple and markedly wasted in the fronto-parietal and upper temporal regions; more on the left side. The wasting is most evident in the prefrontal region including the mesial surface, and in the superior and inferior parietal lobules. Lateral ventricles very large; these and the fourth ventricle show very marked granulations. Cerebro-spinal fluid in considerable excess. Vessels at the base healthy. There is much opacity of the membranes over the cerebellum, especially over its upper surface.

Heart small and pale. Lungs, both lower lobes consolidated with a patch of gangrene in the right lower lobe. Liver small and congested. Kidneys small and pale. Spleen normal. Intestines quite healthy.

Weights of organs in ounces: Brain, 32; lungs, right, $27\frac{1}{2}$, left, $26\frac{1}{3}$; heart, 5; liver, $28\frac{1}{2}$; spleen, $4\frac{1}{2}$; kidneys, $3\frac{1}{4}$ each.

Microscopical Examination.

Cerebrum.—(1) Sections from the following areas were stained with Nissl's and polychrome blue, and by the Heidenhain-erythrosin method: left ascending frontal (top), right first frontal (posterior), left first frontal (middle and anterior), right and left Broca (pars triangularis), left first and second temporal (middle), right superior parietal (middle), left calcarine (posterior limb).

Left ascending frontal convolution.—Pia much thickened, swollen and infiltrated with round cells; its vessels are very congested and their walls thickened. Throughout the grey and white matter the vessels are very prominent; generally congested and surrounded by vast numbers of proliferating glia The cells of their adventitial and endothelial coats especially show much increase and a considerable amount of hyaline change is also seen. The pyramidal layer of nerve-cells is of fair thickness, but many of the cells are very irregular in arrangement. Of the small cells some appear to be fairly healthy, but most are in various stages of acute or chronic degeneration, the acutely affected cells predominating. scattered foci the cells have almost entirely disappeared or are only represented by virtually free nuclei. The larger pyramids and Betz' cells are less affected; many are fairly healthy, others show signs of degeneration, mostly of the acute type. A few cells only contain yellow pigment. There is fairly well marked general glia proliferation, most of which is evidently recent. In the right first frontal convolution (posterior) the appearances are much the same as the above, but there is greater destruction of the small pyramidal cells. In the left first frontal (middle and anterior) there is much more marked diminution of the pyramidal layer with great paucity of cells, those remaining mostly showing advanced degeneration. In Broca's convolutions the nerve-cell destruction is less marked than than in the pre-frontal region, but much more advanced than in the ascending frontal. The left temporal region shows changes about equal to those in Broca's convolutions. In the right superior parietal there is very marked thinning of the pyramidal layer of nerve-cells and destruction of cells almost on a par with that in the prefrontal region. In the calcarine area the acute changes in the nerve-cells are very marked, but the chronic destruction much less so. There is also much swelling of the pia, congestion of the vessels generally, and thickening of their walls; the hyaline degeneration is also as great as in any other part of the cortex examined.

- (2) Blocks from the following areas were stained in Marchi's fluid, and some sections from each block further treated by the iron-alum or ammonium molybdate Pal method. Left ascending frontal and paracentral (various parts); right first frontal (extreme posterior and middle); left first frontal (middle and anterior); right and left second frontal (posterior and middle); right and left Broca (pars triangularis); left third frontal (extreme anterior); left first and second temporal (middle); right superior parietal (middle and posterior); left postero-parietal; right and left calcarine (posterior).
- (a) In Marchi preparations a large number of radial and some inter-radial fibres show recent degeneration in all the above areas; most numerous in the central and calcarine regions, and next most in the right first frontal and left first temporal. In the calcarine area many fibres of the short and long (tapetum and fasciculus longitudinalis inferior) association systems are affected. Many small cells containing darkly-stained particles are seen in the perivascular spaces, intervascular areas, and in the pia. Similar débris also appears to be contained in the endothelial cells of some vessels.
- (b) In Marchi iron-alum Pal specimens, different gyri of the central convolutions are very unequally affected. In many, tangential fibres are fairly abundant as regards fine and medium fibres, but few, if any, coarse ones are seen. Super-radial are more affected than tangential. Inter-radial generally good but diminished in patches. Radii usually little involved. In the whole of the brain examined, in front of the ascending frontal convolution, there is very great atrophy of the nerve-fibres. All the cross layers have practically disappeared, except some of the deeper inter-radii, and the radii are short, tortuous and broken in appearance. Broca's convolutions and the back of the second frontal are affected almost equally with the parts in front of them. The only portion which has escaped comparatively is the back part of the first frontal. The superior parietal and postero-parietal are as much involved almost as the prefrontal; the upper temporal less so. In the calcarine areas the fibres are affected in patches, but on the whole the cross layers are better than in the central region and the radii are practically normal.

The cerebellum.—A portion of one hemisphere and the dentate nucleus examined by Nissl's and the Heidenhain-

erythrosin method; also by the Marchi and Marchi iron-alum Pal methods. Membranes thickened and vessels generally congested. Many of the Purkinje cells are healthy; others show various stages of degeneration. Numerous cells of the dentate nucleus exhibit acute degenerative changes; swelling, chromatolysis and vacuolation. Some projection fibres of the cerebellum and a few fibres entering or leaving the dentate nucleus show recent degeneration. The horizontal fibres of the cerebellar cortex are somewhat diminished and degenerated.

The crus (left) by the Marchi method. A large number of pyramidal fibres and a few fibres of the fronto-cerebellar and temporo-occipital cerebellar systems show recent degeneration. No caudate cerebellar fibres are affected.

The pons (anterior portion), by Nissl's, the Heidenhain-erythrosin and Marchi methods. The cells of the upper nucleus of the fifth nerve are much pigmented; some appear to be almost entirely replaced by pigment, many are shrunken, others swollen and with very eccentric nuclei. The cells of the fillet nucleus are little affected. There is much vascularity and general glia proliferation. Many recently degenerated fibres are seen in the pyramidal bundles; possibly a few fibres of the fillet and superior cerebellar peduncles are also affected.

The medulla (1) by Nissl's and the Heidenhain erythrosin methods. The cells of the twelfth nerve nucleus and of the nucleus ambiguous generally fairly healthy, but some show marked swelling, with considerable chromatolysis. The cells of the tenth sensory nucleus are little affected. Many cells of the posterior column nuclei show swelling, chromatolysis and vacuolation. (2) Various levels by the Marchi method. Many fibres of the anterior pyramids exhibit recent degeneration; few if any fibres affected in other areas of the medulla. None of the cranial nerves show the Marchi reaction.

The spinal cord.—(1) The following segments by the Nissl and Heidenbain-erythrosin methods, C. 5, C. 6, D. 3, D. 8, L. 1, S. 4. The anterior horn cells are on the whole fairly normal; some show shrinkage and atrophy of processes, others swelling, with chromatolysis. The cells of Clarke's column little affected. Membranes thickened; vessels generally congested and thickened, their walls showing practically as much hyaline change as elsewhere. There is also considerable glia proliferation. (2) The following segments by the Marchi and Marchi Pal methods: C. 1, C. 2, C. 5, C. 6, C. 8, D. 4, D. 11, L. 2, L. 4, S. 1, S. 2. A fair number of fibres of the crossed pyramidal tracts show

recent degeneration, rather more on one side than the other. A few fibres of the direct pyramidal tracts are similarly affected, together with scattered fibres in the remainder of the anterolateral and in the posterior columns. A few fibres of the posterior roots are recently degenerated in the sacral, lumbar and lower cervical regions. Some fibres of the anterior commissure and many fine fibres around the anterior horn cells also exhibit the Marchi reaction. Fairly well marked sclerosis is seen in the crossed pyramidal tracts (more on one side), and very slight sclerosis in the direct pyramidal tracts. Practically no sclerosis can be made out in the posterior columns, nor in the posterior or anterior roots.

Case 2.

T. C., male. Age, at the onset of the disease, 14 years; at death, 19 years.

Family history.—Father is in Claybury Asylum; became insane through drink and is now a chronic case. Paternal and maternal grandmothers were drunkards, as are all the father's brothers and sisters. A maternal aunt died of phthisis. There were eight children in the family; no miscarriages. (1) Died at $2\frac{1}{2}$ months; the doctor said if the child had lived it would have been blind and an idiot. (2) The patient. (3) A healthy girl, aged $16\frac{1}{2}$ now; teeth small. (4) A boy, aged 14 now, of stunted growth with typical signs of congenital syphilis,; nose, teeth and rhagades. (5) A boy, aged $11\frac{1}{2}$ now; healthy. (6) A girl, died of bronchitis when 1 year old. (7) A girl, aged 8 now, healthy. (8) A girl, aged 6, not strong.

History and course.—Patient was backward in walking and talking, and could never learn his lessons at school. He worked for some time, however, at a match factory, and was steady in habits. At about the age of 14 he altered, became sullen, refused to eat, or to go to work. When he did go to work behaved strangely, used to strike matches saying he was looking for something. He gradually became worse mentally, and dirty in habits. Sent to Claybury Asylum, September 17, 1898, aged 17 years.

On admission.—Physical: Has a stunted appearance, but is in fairly good condition. Palate high and narrow; teeth coarse, unshapely and irregular in arrangement; pupils equal and dilated, react slightly to light but not to accommodation; Articulation indistinct; walks with feet widely apart; knee-jerks

very exaggerated; no ankle clonus. Mental: Has a depraved expression; is slouching and untidy looking. Is dull, apathetic; sits and stares vacantly in front of him or gazes for long periods into the hollow of his hand and says he is reading the newspaper. Power of attention very limited and intelligence very feeble. Is slow and hesitating in speech; cannot add simple numbers; memory greatly impaired; says the present month (September) is December. Has no idea how long he has been here.

February, 1900.—Remained in much the same state, but latterly has become very demented; wet and dirty in habits; given to masturbation. Bodily condition feeble. Pupils equal, widely dilated and inactive to light; tongue flabby and tremulous; knee-jerks very exaggerated. May 25, 1900.—Is now in the last stage of general paralysis; is in bed with acute erysipelas of the face. Has had several convulsive seizures during the last fortnight. June 1, 1900.—Died of exhaustion at 5.35 p.m.

Post-mortem Examination (June 2, 1900, at 10 a.m.).

The body had been in the cold chamber. Body poorly nourished; arms extremely wasted; large bedsores on sacrum and both buttocks.

Dura not thickened; one or two small adhesions in middle fossæ. Pia-arachnoid markedly thickened and opaque; somewhat adherent to cortex but no decortication where stripped. Subdural space, excess of fluid. Subarachnoid space, considerable excess of fluid, especially in the frontal region. Vessels and sinuses apparently natural. Encephalon typical of general paralysis. Convolutions simple and considerably especially in the frontal region. On section the cortex is dark and translucent; white matter somewhat vascular. Lateral ventricles little dilated but show some small granulations. Fourth ventricles show small granulations throughout. Ribs hard, not brittle. There are three prominent body nodules at the zyphisternal articulation. Lungs show patches of bronchopneumonia. Heart wasted. Aorta exhibits small specks of early atheroma. Liver enlarged and very fatty. Testicles fibrous; right weighed 3.7 grammes, left 3.3 grammes in the Other organs natural except the cæcum, which shows one or two patches of marked congestion.

Weights of organs in grammes.—Encephalon, 1,190; right hemisphere, 502; left hemisphere, 490; cerebellum, pons and

medulla, 175; fluid, 23; liver, 1,540; spleen, 130; kidneys, right, 105, left, 112; lungs, right, 240, left, 280; heart, 190.

Microscopical Examination.

Cerebrum.—(1) Sections from the following areas were stained with Nissl's and polychrome blue, with logwood and eosin, and by the Heidenbain-erythrosin method. Right arm and left leg areas, left first frontal (posterior), right second frontal (middle), right third frontal (anterior), right and left Broca, left second temporal (middle), right supramarginal and right angular, right occipital, including a portion of the calcarine area.

Anterior central convolutions.—Pia thickened and congested. Vessels somewhat congested throughout. Many of the arterioles and capillaries show some thickening of their walls; seldom is this marked, and often it appears to be mostly due to fairly recent proliferation of the adventitial and endothelial elements. Other small vessels are seen which appear to be practically There is some glia proliferation, evidently recent, but little glia fibrillation in the outer layer of the cortex. The pyramidal layer of nerve-cells is not appreciably thinned; most of the small pyramids show signs of chronic degeneration, sometimes advanced. The larger pyramids and Betz cells are mostly little affected, though some are atrophied. The polymorphic cells are little affected. Most of the degenerative changes in the nerve-cells appear to be of the chronic type, although many show swelling and early chromatolysis. In all parts of the cortex examined in front of the ascending frontal convolution there is very marked thinning of the pyramidal layer of nervecells, great diminution in the number of cells, the smaller pyramids especially, and much degeneration, mostly chronic, of those remaining. The cells are also very irregular in their arrangement. These changes are most evident in the prefrontal region. The vessels are even less thickened and prominent generally than in the central cortex. There is little glia proliferation and this is of recent origin. In the temporal region and portions of the inferior parietal lobules there is decided thinning of the pyramidal layer of nerve-cells with atrophy of the smaller cells. The occipital cortex is less involved than any of the other areas examined, but many of the smaller cells show degenerative changes. The line of Gennari is not obviously altered.

(2) Portions from the following areas were stained by the

Marchi and Marchi iron-alum Pal methods: Right leg and left arm areas, right first and third frontal (anterior), left second frontal (middle), left Broca, left first temporal (middle), right angular, right and left calcarine (posterior).

- (a) By the Marchi method: Very few, if any, recently degenerated fibres found in any of the cortical areas examined, excepting a small number in the central convolutions. Also little darkly stained débris seen about the vessels.
- (b) By the Marchi iron-alum Pal method. Anterior central convolutions: Considerable general diminution and degeneration of the tangential fibres, few coarse fibres, and the fine and medium fibres remaining are short and curly. In places, however, the finer fibres are fairly abundant. Super-radials greatly diminished and degenerated; inter-radii and radii little affected. In the prefrontal region all the superficial cross fibres are practically absent, the inter-radii greatly diminished and degenerated, and the radii short, thinned and tortuous. Broca's convolution a fair number of greatly degenerated fine tangential fibres remain in places; the super-radials are very poor; the inter-radials and radials less affected. The temporal region and angular gyrus show changes in the fibres similar to (or rather more advanced than in) Broca's convolution. In the occipital cortex the fibres are better than in any of the other Tangentials generally abundant, areas examined. thinned and degenerated in places. Inter-radii and radii little affected; line of Gennari good.

The cerebellum.—A portion of one hemisphere stained by the Marchi and Marchi iron-alum Pal methods, shows no recent degeneration in any of the fibres. There is some diminution of the cross layer of fibres of the cerebellar cortex; some thickening of the pia and general congestion of the vessels.

The medulla, by the Nissl and Heidenhain-erythrosin methods. At the level of the twelfth nerve nucleus and the nucleus ambiguous; little change is seen in the cells of any of the cranial nerve nuclei or in those of the posterior column nuclei. A few show some degree of chronic degeneration, but most are practically healthy. Vessels considerably congested and show some thickening of their walls. There is little evidence of glia proliferation. Unfortunately the Marchi preparations of the pons and medulla did not penetrate well and are of little value.

The spinal cord.—(1) The following levels stained with Nissl's and polychrome blue: C. 4, C. 5, D. 8, D. 10, L. 2, L. 3. Of the

anterior horn cells some are practically normal, others in various stages of chronic degeneration; a few advanced. There is little apparent alteration of the cells of Clarke's column. (2) The following levels stained by the Marchi method, C. 6, D. 6, L. 2 and L. 5, show recent degeneration of a few fibres in the direct and crossed pyramidal tracts; also of a few scattered fibres in the remainder of the antero-lateral columns and in the posterior columns. None of the anterior or posterior root fibres appear to be distinctly affected. (3) Sections of the cord from the following levels were stained either by the Marchi-Pal method or by the methods of Weigert and van Gieson, C. 3, C. 6. C. 7, C. 8a, D. 2, D. 4, D. 7, D. 11, L. 1, L. 2, L. 5, S. 1 to S. 5, and the coccygeal with the cauda equina. Fairly well marked sclerosis of the crossed pyramidal tracts is seen throughout their entire course, with less evident sclerosis of the direct pyramidal tracts in the upper levels of the cord. Several of the root bundles show definite sclerosis from the coccygeal level to L.1. Above the latter level the roots are less or not at all affected. The sclerosis is patchy in character and affects the posterior oftener than the anterior roots, but at S. 3, S. 2, S. 1 and L. 5 especially some of the anterior root bundles are similarly involved. There is distinct sclerosis of the posterior columns in their outer and middle portions from S. 3 to L. 1. At D. 11 there is diffuse partial sclerosis of Goll's columns, the lateral portions particularly, and some sclerosis of the dorsal and median root zones. Similar changes are seen at each of the levels examined up to C. 6, excepting that in the cervical region the sclerosis of Goll's columns reaches further forwards, almost to the posterior commissure. At C. 3 the sclerosis of the posterior portion of the cord is limited to Goll's columns and does not extend so far ventrally. The lesions are very symmetrical throughout. The membranes are much thickened, their vessels enormously engorged and much thickened at all the levels examined, but most so in the coccygeal, sacral, lumbar and lower cervical regions. The vessels of the nerve roots are similarly affected, especially in the more sclerosed bundles. The vessels of the cord itself are also generally very prominent. The changes in this case resemble closely those seen in Case 4.

The third lumbar posterior spinal ganglia, fixed in 96 per cent. alcohol and stained by Nissl's method. The cells are somewhat shrunken (probably from the fixation, &c.), but otherwise show little alteration. The cells contain remarkably little pigment.

The optic nerves, stained by Marchi's method. Both nerves are small; there is much increase of connective tissue and great congestion of the vessels with thickening of their walls. A considerable number of fibres remain in both nerves and some of these show distinct evidence of recent degeneration.

Case 3.

L. B., female. Age at the onset of the disease about 14; at death, 18 years.

Family history.—Very incomplete. Mother died of general paralysis, aged 42. Patient is the second of a family of four, two of whom are now living.

History and course.—Patient's eyesight has been defective from birth, but she is said to have been quick and intelligent at a blind school; was fond of books, and was a lively, cheerful girl. At about the age of 14 her intelligence became clouded. She was often dull and morose, and at times noisy and violent, threatening to kill herself. She then became dazed, dirty in her habits, and unable to look after herself. She was sent to Hanwell Asylum in April, 1897, aged 15 years.

On admission.—She had an imbecile expression; very dull and depressed, only answering questions after much persuasion. Memory much impaired. She was well nourished. Head: circumference $21\frac{3}{4}$ inches; deformity of cranial vault resembling the "hot cross bun" of syphilis; forehead prominent, nose small, lower jaw receding, teeth fair, palate narrow. The eyes showed slight exophthalmos, with external strabismus of the left eye. Eyesight very defective; pupils equal, dilated and sluggish in reaction. No tremor nor paresis observable. Knee-jerks exaggerated.

In 1897 and 1898 she remained in much the same state, rarely speaking; content to do what she was told, but unable to initiate anything; generally depressed and apathetic, with delusions, such as that dogs were coming after her. In May, 1900, it was noted that the dementia has increased considerably during the previous six months. She was then almost in a condition of stupor, taking no notice of her surroundings and not speaking at all. She appeared to be very helpless; was unable to walk, to feed or dress herself. She was wet and dirty in habits. The pupils were dilated and sluggish and the kneejerks exaggerated. She gradually became more emaciated.

paretic and demented, and died on December 11, 1900. She appears to have had no seizures at any time during her illness.

Post-mortem Examination.

December 12.—Body extremely emaciated; no marks. Calvarium symmetrical; fronto-parietal suture depressed and the portions of the parietals forming its anterior superior angles are more prominent than usual, being somewhat bossy. Dura normal. Pia-arachnoid opaque and thickened in the frontal, central and parietal regions; the whole pia is ædematous, and here and there are a few extravasations of blood-stained fluid. There is considerable excess of clear cerebro-spinal fluid. The brain is of fair size. Convolutions somewhat simple, and there is some wasting generally, marked in the prefrontal region and less marked in the superior and inferior parietal lobules, and in the upper temporal regions; both sides about equally affected. Lateral ventricles decidedly dilated; walls slightly granular. Many fine granulations seen in fourth ventricle. The sinuses contain a little black dot. Vessels at the base healthy. Optic nerves wasted and the spinal cord appears to be small.

Heart small, otherwise healthy. Lungs, right, upper half of lower lobe solid from broncho-pneumonia; left, lower part of the upper lobe in a similar condition. No sign of tubercle in either lung. Liver small, congested and friable. Spleen dense and firm with opaque thickenings of the capsule. Kidneys slightly fatty, capsules non-adherent. Adrenals healthy. Uterus and tubes healthy. Ovaries small, and the left has a cyst the size of a walnut attached. Stomach, intestines and pancreas quite normal in aspect.

Weights of organs.—Brain, in all, 42 ozs.; heart, 5 ozs.; lungs, right, 13 ozs., left, 8 ozs.; liver, 26 ozs.; spleen, 3 ozs.; kidneys, right, 3 ozs., left, 4 ozs.

Microscopical Examination.

Cerebrum.—(1) Portions from the following areas were stained with Nissl's and polychrome blue and by the Heidenhain-erythrosin method. Right and left ascending frontal and parietal (top), left extreme prefrontal, right second frontal (middle), right and left Broca (pars triangularis), right posteroparietal, right and left first temporal (anterior), right calcarine (anterior), left calcarine (anterior and posterior).

The central convolutions.—Pia considerably thickened and much swollen; its vessels congested, especially the smaller veins. Vessels throughout the grey and white matter generally congested, their walls, in some instances, show thickening and hyaline change, but many arterioles and capillaries are seen whose walls are apparently normal. The pyramidal layer of nerve cells is somewhat diminished in thickness, and there is distinct paucity of cells, many of which show irregularity in arrangement. Some of the smaller cells are fairly normal, but many are seen in all stages of chronic degeneration. In scattered foci are cells with pale, swollen nuclei and commencing chromatolysis. The larger pyramids and Betz cells are less affected on the whole, but some show advanced degeneration. Early acute change is seen in many cells. There is some fairly general glia proliferation, but the glia cells appear to be mostly recently formed, and have indefinite processes. the portions of the cortex examined in front of the ascending frontal convolutions, there is more marked thinning of the pyramidal layer and destruction, especially of the smaller nerve cells, which also are more irregular in arrangement. degenerative changes are more advanced in the prefrontal region than in Broca's convolutions. The pia is also more thickened than in the central convolutions, and the glia proliferation, though not more extensive, is evidently older. In the posteroparietal convolution there is almost as much thinning of the pyramidal layer and distribution of nerve cells as in the prefrontal region, whilst the vascular and glial changes are comparatively slight. The temporal regions are affected about as much as are Broca's convolutions, and the left side rather more than the right. The calcarine areas are little involved, except for some swelling of the majority of the cells. The granule layers and Gennari's line are perhaps somewhat thinned.

- (2) Portions of the brain from the following areas were stained by the *Marchi method* and by the *Marchi iron-alum Pal method*: Left ascending frontal (top), right ascending parietal (top), right and left Broca (pars triangularis), right first frontal (back), left extreme prefrontal, right superior parietal (middle), left first and second temporal (middle), left calcarine (anterior and posterior).
- (a) In Marchi specimens a few recently degenerated radial fibres are seen in the central convolutions. No radial fibres exhibit recent degeneration in any other part of the cortex examined. In the calcarine area recent degeneration is observed

in some fibres cut transversely and obliquely situated below the bottom of the stratum calcarinum, between this and the posterior horn of the lateral ventricle. These are probably fibres belonging to the tapetum and fasciculus longitudinalis inferior.

(b) In Marchi iron-alum Pal preparations, the central convolutions show a fair abundance of tangential fibres, although these are much diminished in patches; the super-radial are less numerous and more degenerated. The inter-radials and radii are generally good, excepting that the former are greatly diminished in scattered foci. The fibres on the whole are better in the ascending frontal than in the ascending parietal gyri. In Broca's convolutions the tangentials are greatly diminished and degenerated, the super-radials are almost absent; the interradials diminished and degenerated; the radii little affected. Left Broca is rather worse than the right. At the back of the first frontal the fibres are better than in Broca's convolutions, but more affected than in the ascending frontal. In the prefrontal region all the cross layers of fibres are practically absent and the radii are considerably degenerated. In the superior parietal lobule the tangential fibres are few in number and appear in short lengths; there are no coarse fibres; the superradial are very diminished; the inter-radial and radial are much less affected. The temporal region shows very great thinning of the tangential and super-radial fibres with much degeneration; the inter-radial are diminished in patches; the radii are fair. In the calcarine area generally the fibres are equal to or better than in the ascending frontal; Gennari's line shows patchy degeneration.

A noticeable feature in this case is the general absence of glia cells and processes so well seen by the Marchi iron-alum Pal method in several other cases.

The cerebellum.—A portion of the left hemisphere and corpus dentatum stained by the methods of Nissl, Marchi, and Marchi iron-alum Pal. The Purkinje cells are somewhat diminished and degenerated; there is thickening of the membranes and general congestion. No nerve fibres show recent degeneration; the horizontal fibres of the cerebellar cortex are thinned. The cells of the dentate nucleus appear to be generally healthy.

The crus, pons and medulla.—A fairly complete set of sections stained by the Marchi and Marchi-Pal methods show little of interest excepting that a few of the pyramidal fibres of the crusta and of the pontine and medullary pyramids exhibit recent degeneration. Possibly a few fibres of the lateral and mesial fillets are also affected.

The medulla by Nissl's method, at the level of the twelfth nerve nucleus and the nucleus ambiguous. Most of the cells of the cranial nerve nuclei are practically normal. A few show chronic degenerative changes and some are swollen. The vessels are somewhat congested.

The spinal cord.—Sections at several levels stained with Nissl's and with polychrome blue show little affection of the anterior horn cells, most of which are practically normal. Some show chronic and acute degenerative changes. The vessels are somewhat congested, but there is little structural change in their walls and little glia proliferation. The following segments were stained by the Marchi, Marchi-Pal and Van Gieson methods: C. 8, D. 3, D. 10, D. 11, L. 1, to L. 5 and S. 1. In Marchi preparations a few recently degenerated fibres are seen in the direct and crossed pyramidal tracts, and a few scattered fibres similarly affected in the remainder of the antero-lateral and posterior columns. Many of the anterior horn cells contain black pigment. Definite but not very marked sclerosis is observed in the direct and crossed pyramidal tracts. There is slight affection of Lissauer's tract in the lumbar cord, but little if any sclerosis in the posterior columns throughout. Neither the anterior nor posterior nerve roots appear to be affected.

Posterior spinal ganglia.—The third lumbar, stained by Marchi's method, shows no obvious change. The cells are not excessively pigmented. The fourth lumbar, hardened in formalin and stained by Nissl's method. The cells are somewhat shrunken (probably owing to the methods employed), but otherwise show little change. Few of the cells contain any pigment.

The optic nerves in longitudinal and cross section stained by Van Gieson's method. Both nerves are much atrophied. There is great increase of connective tissue, especially in patches, and much neuroglia proliferation. The nerve-fibres are apparently greatly diminished in numbers. The vessels are not at all prominent.

The uterus.—The body of the uterus appears to be normal except for under development. The true muscular wall is much thinner than normal in a female of 18 years. The muscle fibres are very small but there is no increase of fibrous tissue. The muscularis mucosa is highly vascular but the vessels are natural; the muscle fibres also on the whole are better developed than in the true muscular coat. In the mucous membrane the tubules are small and simply convoluted; the cells also are

embryonic in appearance, and the cells between the tubules show a want of differentiation. Where the surface of the inner wall of the uterus is preserved in the sections, the smooth single layer of surface epithelium together with the condition of the underlying parts suggests that menstruation never occurred.

The cervix shows dilatation of the ducts of the arborescent glands with excess of mucin; the deeper parts of the glands are normal and there is no excess of fibrous tissue.

The ovaries have an embryonic appearance but are otherwise normal. The number of follicles is exceedingly small, but in spite of this there are several fairly developed follicles in both ovaries. Only one corpus luteum was found.

The Fallopian tubes are practically normal.

Case 4.

H. A., male. Age at the onset of the disease, 17; at death, 20 years.

Family history.—Mother was in Brentwood Asylum three times with puerperal melancholia; the first time after the birth of her second child, and finally after the birth of her ninth child. She died in the asylum four months later of a "paralytic stroke." She was married at 17 years of age, and her first child was born before her marriage. Patient is the eighth of nine children; no miscarriages. Three of the children died of natural causes, one of them at 4 months old. The father states with certainty that he never had syphilis, and that his wife had not, at least after marriage.

History and course.—Patient was a hardy lad; does not appear to have been mentally deficient up to the time of his illness, and earned his living as a kitchen boy in a restaurant. He was not of steady habits, however—drank and smoked since he was 13 years of age. When 17 years old he fell down stairs and injured his head and knee. He was very confused afterwards and had "no notion of anything." He remained at home for a fortnight and then went back to work, but "did everything wrong." He gradually became more "soft and silly," and eventually was sent to Mile End Infirmary, where he remained for about a year; after which he was admitted to Claybury Asylum. While at Mile End Infirmary he is said to have masturbated a good deal.

On admission to Claybury Asylum, March 7, 1900, his facial

expression was blank; he had a restless, frightened manner; could not understand the simplest questions, and could not even tell his name. He muttered to himself or made senseless remarks; was wet and dirty in habits; took his food ravenously. He was in feeble health; had "marked signs of congenital syphilis; " notched central incisors, and prominent horizontal and transverse ridges on the head and corneal opacity. The pupils were unequal, irregular in contour, and fixed; marked tremors of the facial muscles on movement; tongue jerky and tremulous; speech muttering only. He was unable to stand alone; gait very ataxic. Knee-jerks could not be obtained, but contraction of the hamstrings occurred with each tap on the patella. Sensation in the legs apparently normal. The arm reflexes could not be obtained, but the patient was very resistive. He went down hill rapidly, becoming more emaciated, feeble and helpless. On April 12 he was found to have a dorsal dislocation of the right hip joint—cause unknown—and he died on April 14, 1900, at 5.20 p.m., having had no seizure since admission.

Post-mortem Examination.

On April 16th, at 12 noon, the body having been in the cold chamber. Body very emaciated. Bedsores on sacrum, both knees, legs, malleoli and heels. Right leg markedly swollen. There is dorsal dislocation of the right hip joint, the whole region containing about a quart of blood-stained pus.*

Skull congested. Dura natural. There is a large excess of subdural and subarachnoid fluid. Pia-arachnoid opaque, and is markedly thickened, and there is extreme decortication on stripping. There are marked mid-line prefrontal adhesions.

The encephalon is typical of general paralysis. Convolutions wasted, especially in the frontal region (most in the prefrontal), in parts of the superior and inferior parietal lobules, and in the upper temporal regions. On section the cortex and white matter are congested. The lateral ventricles are markedly dilated and granular. The fourth ventricle is typically granular.

^{*} Note by Dr. Bolton.—The hip-joint was carefully dissected. The posterior part of the capsule is torn, the rest natural. The cartilages are somewhat softened through being bathed in pus, but show no erosion, proving that the abscess followed the dislocation. The condition is probably of one to two weeks' duration and due to injury, the damaged parts being subsequently infected owing to the general septic condition of the patient.

Ribs brittle. Right pleura is universally adherent. Right lung contains a number of foci of active tubercle. Left pleura and left lung natural. Heart normal. Aorta, there is a moderate amount of first and second stage atheroma; this being extremely marked for the age of the patient. Liver large, fatty and friable. Spleen slightly dense. Kidneys congested; cortex pale and rather denser than natural. Testicles small and rather dense. Stomach natural. Small intestines, in lower, four or five feet transverse scars of old tuberculous ulcers are seen. Large intestine shows some patchy congestion.

Weights of organs in grammes.—Encephalon, total 1,190 (right hemisphere, stripped, 485; left hemisphere, stripped, 465; cerebellum, &., 170; fluid, 70). Liver, 970; spleen, 75; kidneys, right, 130, left, 125; lungs, right, 300, left, 280; heart, 140.

Microscopical Examination.

Cerebrum.—(1) Sections from the following areas stained with Nissl's and with polychrome blue, and by the Heidenhain-erythrosin method: Right ascending frontal (top), left ascending frontal (leg and arm areas), left Broca's convolutions (pars triangularis), right supramarginal, right calcarine (posterior).

Anterior central convolutions.—Pia thickened and its vessels Vessels throughout considerably congested much congested. and their walls mostly thickened and cellular, with a fair amount of hyaline change. The pyramidal layer of nerve-cells not markedly thinned, and the cells on the whole not much diminished in number. Most of the cells in all the layers, however, show at least some degenerative change, the small and medium pyramids being most affected; some of the former being represented only by free nuclei. Betz cells numerous, some fairly normal; a few very degenerated. In all the layers swollen cells (usually in scattered groups) occur; some are greatly swollen with large, clear, eccentric nuclei. Numbers of small round cells are seen. There is general hypertrophy and proliferation of the glia, most evident around the vessels; much of this seems to be recent, but there is some fibrillation in the molecular layer. Left Broca's convolution shows similar changes to the above. The pyramidal layer is perhaps thinner, and there is more destruction of the smaller nerve-cells. The supramarginal conrolution is much more affected. The pyramidal layer is greatly diminished; there is marked paucity of the smaller cells and the remainder show mostly advanced degeneration. The larger pyramids are also not so good as in the other areas examined. There is not so much vascular congestion, nor so much neuroglia proliferation as in other areas. In the calcarine area the vessel and neuroglia changes are equal to those in the central convolutions. There is much swelling of the smaller pyramids; the larger being less affected, many being practically normal.

- (2) Portions from the following areas by the Marchi and Marchi iron-alum Pal methods: Right and left ascending frontal (top), right and left Broca (pars triangularis), right second frontal (back), right extreme prefrontal, right and left first and second temporal (middle), right superior parietal (middle), right calcarine (anterior).
- (a) In Marchi preparations some recently degenerated radial fibres are seen in the central convolutions, but few fibres so affected in any of the other areas.
- (b) In Marchi iron-alum Pal specimens the anterior central convolutions show considerable general diminution and degeneration of the tangential fibres, though in places a fair number (fine and medium) remain. Superradials much lessened and degenerated; interradials and radials little affected. In left Broca the fibres are as good or better than in the central area, but in right Broca the upper cross layers are distinctly more degenerated. In the prefrontal region all the cross layers have practically disappeared and there is much degeneration of the radii. In the temporal regions the condition of the fibres is about equal to that seen in right Broca, whilst in the superior parietal it is almost as bad as in the prefrontal region. The calcarine area shows comparatively little affection of the fibres.

The cerebellum.—A portion of one hemisphere by the Marchi Marchi iron-alum Pal and Van Gieson methods. Membranes thickened. Vessels thickened and congested generally. There appears to be some diminution and degeneration of the Purkinje cells; a very few projection fibres show recent degeneration, and the horizontal fibres of the cortex are somewhat lessened and degenerated.

The pons and medulla.—At various levels by the Marchi and Marchi iron-alum Pal methods. A fair number of fibres in the pyramidal bundles of the pons and anterior pyramids of the medulla show recent degeneration, as do a very few scattered fibres generally. None of the cranial nerves exhibit recent degeneration by the Marchi method. In the neighbourhood of the posterior column nuclei in the medulla there is some amount of sclerosis.

The spinal cord.—(1) The following levels by the Marchi method: C. 3, C. 5, D. 5, D. 7, D. 11, D. 12, L. 4. A fair number of fibres in the crossed and a few in the direct pyramidal tracts show recent degeneration, especially in the upper levels of the cord. A few scattered fibres exhibit recent degeneration in the remainder of the antero-lateral columns. In the posterior columns very few fibres show recent change in the cervical region, but a fair number are so affected in the lower dorsal and lumbar regions, both endogenous and exogenous fibres. It is doubtful if any of the anterior or posterior roots near their union with the cord are involved. In the anterior cornual cells and in those of Clarke's column there is a large amount of darkly-stained pigment.

(2) The following levels by the Marchi-Pal, Weigert and Van Gieson methods: C. 3, C. 5, C. 7, C. 8 (b), D. 2, D. 5, D. 7, D. 10, D. 11, L. 2, L. 3, L. 5, S. 2, S. 3, S. 4, S. 5. Coccygeal with cauda. There is definite, though not very marked sclerosis of the crossed pyramidal tracts, especially in the upper levels, with less definite sclerosis of the direct pyramidal tracts. each level, from the coccygeal to D. 2, several root bundles on either side, near their union with the cord, show distinct sclerosis varying in amount at different levels. The posterior roots are more markedly sclerosed than the anterior at each of these levels but at S. 5, S. 4, and D. 11, especially, there is distinct affection of some of the anterior root bundles as well. With regard to the posterior columns there is partial sclerosis affecting the middle of each column, not reaching mesially to the fissure, nor laterally to the posterior horn, from S. 4 to D. 11. At D. 10 there is marked sclerosis of the root fibres near the posterior horns, with a long and slender patch of sclerosis at the outer part of Goll's columns. Similar changes are seen at D. 7, D. 5, and D. 2. At C. 8 more marked sclerosis of Goll's column and definite sclerosis of the median root zone. At C.7 and C. 5 there is more diffused sclerosis of Goll's column (most marked about the intermediate furrow, extending in this direction almost to the posterior commissure), with some sclerosis of the modern root zone. At C. 3 the changes are similar, but in Goll's column do not extend so far ventrally and the median root zone is less affected. Lissauer's tract is slightly affected at all the levels examined, varying in amount at different levels. The membranes are much thickened at all the levels; their vessels are extremely congested and have thickened walls. The vessels of the nerve roots show a similar condition, especially in the

roots most affected. The vessels of the cord itself are also very prominent as regards congestion and thickening.

Case 5.

M. C., female. Age at the onset of the disease, 14; at death, 19 years.

Family history.—From the mother, who is a dull, phlegmatic woman, blind in the right eye from small-pox and deaf. No insanity in the family. Mother's sister died of phthisis. Parents married at the ages of 24. There were fourteen pregnancies, four of which resulted in miscarriages. Three children died—one of rickets and the others of "children's diseases." Patient was the third child.

History and course.—Patient was born at full term, but was a small baby. She took scarlet fever when 14 days old, and partially lost the sight of her left eye. She attended school and was able to read and write, but "being delicate did not get on so well as the others." She gradually lost sight in both eyes and became completely blind at 12 years of age. She was sent to a blind institution where she remained till she was 15, being "quite normal mentally" up till the latter part of this time. The attendants then noticed that she had "religious delusions." She also began to menstruate and "lost a good deal of blood for a child." She was sent home owing to her mental condition; was transferred to the Infirmary, and thence to Claybury Asylum on June 6, 1896, aged 15 years.

On admission.—Physical: Is in fair health and condition; quite blind in both eyes, with old opacities on lower part of left cornea. Pupils unequal, irregular and inactive to light. Teeth peg-shaped. Tongue ulcerated. Reflexes normal. Mental: Is simple and childish; at times spiteful. Says she can read the blind alphabet, but hesitates on adding simple numbers. Talks readily; says she worried because at the first communion six years ago she did not confess all her sins; that she prays too much; that the devil talks to her at night and asks her to sell her soul; that her mother sold her soul for "£30 and silk dresses"; also that the Dear Lady appeared to her and told her she was going to take her to heaven.

April, 1897.—Has been noisy, violent and impulsive at times; has aural hallucinations, which she attributes to telephones; has exaggerated religious ideas and crosses herself when spoken to; has become very dirty in habits. December, 1899.—Has

gradually gone down hill physically and mentally; memory and intelligence now very defective. January 1, 1900.—Is more feeble and emaciated; very demented; sent to bed to-day. March 6, 1900.—Has failed more rapidly of late and has become very emaciated. Died at 9.40 p.m. No convulsive seizures are recorded during any part of her illness.

Post-mortem Examination.

At 10.30 a.m., March 7. The body had been in the cold chamber. Body very emaciated; bedsores on both hips; right foot inflamed.

slightly thickened. Pia - arachnoid Dura opaque and thickened generally, especially over the fronto-parietal regions and about the Sylvian fissure, and at the base; mid-line prefrontal adhesions well marked. The subdural space contains an enormous excess and the subarachnoid space an excess of fluid. Vessels and sinuses dilated and contain dark blood. The encephalon is typical of general paralysis; convolutions wasted generally, but especially in the frontal region. The cortex has a dark, translucent aspect; the white matter is rather dense and vascular. Lateral ventricles enormously dilated and very granular. Fourth ventricle very granular throughout. Optic nerves decidedly atrophied. Ribs hard. Lungs, left, natural; right, very ædematous and shows signs of recent tubercular infection. Heart extremely wasted. Liver congested and extremely dense. Spleen small and extremely dense. Kidneys both congested and very dense, especially left. Ovaries and uterus small. Stomach, intestines and other organs quite natural.

Weights of organs in grammes: Encephalon, 1,135; heart, 120; lungs, right, 280, left, 160; liver, 500; spleen, 22; kidneys, right, 80, left, 75.

Microscopical Examination.

Cerebrum.—(1) Sections from the following areas were stained with Nissl's and with polychrome blue; some also by the Heidenheim erythrosin method, with logwood and eosin, and by the sodium carminate method: Right and left ascending frontal (top), right ascending parietal (top), left second frontal (middle and posterior), left Broca (pars triangularis and pars orbitalis), right and left calcarine (posterior).

Right and left ascending frontal.—Pia thickened, swollen and infiltrated with small round cells; its vessels are very con-

gested and their walls thickened. The vessels throughout are very congested and cellular; there is some amount of hyaline change. Much of the cellularity about the vessels appears to be of quite recent origin and to be due to enormous proliferation of neuroglia. At the same time many of the adventitial and endothelial elements are swollen and seem to be dividing. the outer layer of the cortex there are many newly-formed neuroglia cells but not any great amount of fibrillation. The perivascular spaces are dilated and some contain minute hæmorrhagic extravasations or hæmatoidin crystals. The pyramidal layer of nerve-cells is not appreciably thinned. Very large numbers of the smaller cells are in various stages of acute degeneration, the majority being swollen, vacuolated and showing advanced chromatolysis. The nuclei are less swollen but tend to stain diffusely. The cellular reticulum is generally much broken down. Of the medium and larger pyramids a few are of fairly normal shape with good processes, but no definite Nissl blocks; they tend to stain diffusely. Some show signs of coagulative necrosis, others are in various stages of chronic degeneration. The majority, however, show the effects of cedema with swollen, ill-defined, ragged edges, chromatolysis and vacuolation. The number of cells showing advanced acute destructive changes is enormous, especially on the right side. The Betz cells are comparatively few in these sections; those seen are less involved than are the smaller cells. Right ascending parietal.—The appearances generally are much the same as the above, but there is less recent neuroglia proliferation; most of the neuroglia cells are evidently older and with better defined processes. In parts of the section the pyramidal layer is distinctly thinned, and there are foci largely denuded of nerve-cells. Left second frontal (middle and posterior) and left Broca.—The pyramidal layer of nerve-cells is markedly thinned and the smaller pyramids distinctly diminished in number. Those remaining are in various stages of degeneration, but the acute changes are not nearly so pronounced as in the central convolutions. The larger pyramids are less affected, but none are normal in appearance. The pia is much thickened and the vessels throughout congested and thickened. The neuroglia development is evidently of longer standing than in the ascending frontal convolutions, and there is marked fibrillation, especially in the molecular layer. Right and left calcarine.—There is no decided thinning of any of the cortical layers and the line of Gennari is of normal thickness. Many of the smaller cells show advanced degenerative changes,

especially of the acute type. Vessels very congested and thickened.

- (2) Portions from the following areas by the Marchi and Marchi iron-alum Pal methods: Right and left ascending frontal and parietal (top), left third frontal (anterior), left first and second temporal (middle), right and left calcarine (posterior).
- (a) By the Marchi method, a considerable number of radial fibres and a few deeper interradial fibres show recent degeneration in the right central convolutions and a lesser number in the left central convolutions. There is a good deal of darkly stained débris in the perivascular spaces, also contained in the vascular endothelial cells and in "carrier cells." In the other regions the recently degenerated fibres are not so numerous.
- (b) By the Marchi iron-alum Pal method. Right central convolutions.—Tangential fibres diminished generally, especially in patches; in places, however, they are fairly abundant, particularly the fine fibres; no coarse and very few medium fibres Superradials relatively more diminished and de-Radii and interradii little generated than the tangential. affected. Left central convolutions.—Tangentials diminished in patches, but in places abundant and almost healthy; coarse, medium and fine fibres present. Superradials not so good. Radii and interradii practically normal. In the third left frontal all the fibres of the upper cross layers have disappeared; the deeper interradials remaining are much degenerated; the radii are thinned, tortuous and broken-looking at their summits, which fall very short. In the temporal region the appearances are much the same, the atrophy not being perhaps quite so advanced. In the calcarine areas the tangentials are generally abundant (though lessened in places), but show some sign of degeneration, as do the superradials. The interradii and radii and line of Gennari are practically normal.

The medulla.—At various levels by the methods of Marchi and of Weigert. A considerable number of fibres of the motor decussation and of the anterior pyramids show recent degeneration, as do a very few scattered fibres elsewhere. There is some sclerosis in the neighbourhood of the posterior column nuclei.

The spinal cord was very brittle and sections were obtained with difficulty. The following levels stained by the Marchi method: C. 4, D. 7, L. 2 and L. 3 showed recent degeneration of a considerable number of fibres of the crossed (more on one side) and of a few fibres of the direct pyramidal tracts in the cervical region especially. Scattered fibres in the rest of the antero-lateral and in the posterior columns are similarly affected.

The following levels were stained by Van Gieson's method and with carmine: C. 4, C. 5, D. 5, D. 7, L. 1 to L. 4. Membranes much thickened; vessels thickened and congested and there is much increase of neuroglia. There is fairly well-marked sclerosis of the pyramidal tracts throughout. In the cervical region there is distinct sclerosis of Goll's column, of Lissauer's tract, and of the dorsal root zone. In the lower levels of the cord sclerosis of the posterior columns is seen in similar situations, but Goll's column is less affected. There is some sclerosis of the entering posterior roots. The anterior horn cells appear to be little altered.

The posterior spinal ganglia.—The third cervical, seventh dorsal and fourth lumbar stained by Van Gieson's method show little alteration of the cells as a rule. Some contain a considerable amount of pigment, the smaller cells especially, and a few appear to be degenerated.

The optic nerves, stained by the methods of Marchi, Weigert, Van Gieson, and by logwood and eosin. Both nerves are very small, especially the left. There is much increase of connective tissue; the nerve-fibres are greatly diminished in number, but none show any evidence of recent degeneration by the Marchi method.

Case ô.

H. R., male. Age at the onset of the disease unknown; at death, 18 years.

History.—From the mother. Patient is the only one living of nine children; seven were born dead, and one who was very sickly died at the age of 2 years. Patient had fits when he was 3 years old, but from that time until August, 1898 (when he was 16 years of age), he had no fits.

Course.—He was able to earn his own living for a time as a labourer, but in 1898 appears to have become incapable of looking after himself, and was sent to the workhouse. Whilst there he had several fits and had delusions of persecution, viz., that his medicine was poisoned and that people were trying to kill him; that the walls were falling on him and that he was smothered in blood. He had also hallucinations of sight, seeing imaginary people and trying to catch hold of imaginary objects. He was sent to Colney Hatch on November 25, 1899.

On admission he was in a very dazed state, lying in bed

"like a log"; did not speak a word; was wet and dirty in habits and refused food. Bodily condition feeble. Pulse quick but regular. Head of normal shape. Vascular and respiratory organs and abdominal viscera apparently healthy. Condition as to signs of syphilis not noted. Pupils dilated; equal; react sluggishly to light. Limbs contracted. On November 28 he had an epileptic fit during the night, and his condition was very weak. On December 2 he had other fits during the night. On December 5 he had a very strong fit, from which he did not recover.

Only scanty clinical notes of this case were obtained, but the patient was seen by Dr. Mott, who came to the conclusion that the case was undoubtedly one of juvenile general paralysis.

Notes of post-morten examination, performed on date of death.

Calvarium natural. Dura thickened. Pia very edematous, thickened and firmly adherent where stripping was attempted. There are marked mid-line prefrontal adhesions. The brain appears to be small; there is much opacity of the soft membranes, especially in the fronto-parietal and upper temporal regions. Convolutions very wasted in these areas, mostly markedly so in the prefrontal. Both sides of the brain are about equally affected. Lateral ventricles are dilated; those and the fourth ventricle show numerous fine granulations. Cerebrospinal fluid excessive. There is some thickening and opacity of the membranes over the upper and lateral surfaces of the cerebellum. Lungs edematous. Heart small, otherwise healthy; very marked atheroma of the arch of the aorta. The abdominal viscera appear to be healthy. Weights of organs not obtained.

Microscopical Examination.

Cerebrum.—(1) The left ascending frontal (top) and paracentral convolutions stained with Nissl's and polychrome blue. The pia is thickened and swollen; its vessels are very congested. The vessels generally are congested and their walls are thickened and cellular. The pyramidal layer of nerve-cells is somewhat diminished in thickness and many cells show advanced degenerative changes, especially the smaller pyramids. Numbers of the medium-sized cells are also shrunken, with tortuosity of the apical processes. The larger pyramids and Betz cells are less affected; some have a fairly normal aspect, others show various stages of degeneration. Occasional foci are seen of acutely altered

cells. There is some fairly general neuroglia proliferation, which is most evident in the molecular layer. The left first frontal (middle) and right calcarine areas, stained in the same manner, show similar changes; they are more advanced, however, in the frontal region and less so in the calcarine. In the frontal the pyramidal layer is distinctly thinned, and there is marked destruction of the smaller cells especially. In both areas there is much congestion and thickening of the vessels and more neuroglia proliferation than in the central region.

(2) Blocks from the following areas were stained by the Marchi and Marchi iron-alum Pal methods: Left ascending frontal top and paracentral, right ascending parietal (top), right third frontal (middle), right and left calcarine (posterior).

In Marchi preparations a few radial fibres show recent degeneration in all these areas, most in the central and calcarine. Some darkly-stained particles are seen in the perivascular spaces, vascular endothelium, and in scattered "carrier" cells.

In the central convolutions, by the Marchi iron-alum Pal method, the tangential fibres are generally in abundance, though comparatively diminished in places. Fine, medium and coarse fibres are present, but the latter especially are excessively varicose and appear broken into short lengths. The superradial fibres are abundant, but usually short. The interradii and radii are on the whole little affected. The fibres are not so good in the ascending parietal as in the ascending frontal and paracentral convolutions. The calcarine areas present much the same appearance as regards the fibres as do the latter convolutions. In the third frontal the tangential and superradial fibres are practically absent, the interradial much diminished and degenerated, and the radii have a curly and broken appearance.

The cerebellum.—By the Marchi method, a few projection fibres show recent degeneration. By the Marchi iron-alum Pal method there appears to be considerable diminution and degeneration of the cross fibres of the cortex. The membranes are thickened and the vessels generally congested.

The pons at two levels, stained by the Marchi method. Beyond a few fibres of the pyramidal bundles showing recent degeneration, no others practically appear to be involved. The fibres of the cranial nerves, so far as observed, are free from signs of degeneration.

The medulla at various levels, stained by the Marchi and Marchi iron-alum Pal methods. A few of the pyramidal fibres show recent degeneration. It is doubtful if any of the inter-

olivary or restiform fibres are affected. At the lowest level some scattered fibres of the posterior columns exhibit recent degeneration. The spinal cord was not obtained.

Case 7.

E. N., female. Age at the onset of the disease, 13 (probably); at death, 17 years.

I am much indebted to Dr. Stansfield for the very complete notes of this case. The following is a brief abstract.

Family history.—From the mother. Maternal grandparent was insane and in Brentwood Asylum. Maternal aunt and uncle died of phthisis. Parents married at the age of 20 (F.) and 21 (M.) years. Mother's pregnancies were as follows: (1) Miscarriage at six weeks; (2) patient; (3) girl, healthy; (4) boy, died in four hours; (5) boy, who had fits up to 7 years of age; (6) boy, premature, at six months; (7) boy, died at 6 months; (8) boy; (9) girl; both latter healthy.

History and course.—Patient was born at full term after an instrumental labour. As a child had snuffles and a rash on the wrists. She cut her first tooth at 8 months and began to walk and talk at 24 months. She was a simple, emotional and excitable child, and was inclined to steal. Going to school until 14 years of age she could not be taught and passed no standard. She was, however, able to do a little housework. She was noticed to become more timid, emotional and impulsive. When 13 years old she had a fit, and afterwards about four times a week had twitching of the left arm. She became more restless and excitable; would not stay in bed; wandered about; could not dress herself, and her habits became wet and dirty. A month before admission to Bexley Asylum she had a severe fit, and afterwards became rapidly worse mentally and physically. Since 14 years of age she suffered, especially at night, from "dreadful pains" in the frontal region. She never menstruated. mitted to Bexley Asylum November 24, 1900, aged 16 years.

On admission.—(1) Physical: Weight, 6 st. $2\frac{1}{2}$ lbs. Poorly nourished; scars on front of right leg; some pigmentation of the skin round the waist and over the lower end of the left ulna. Circumference of cranium, 52 cm. Face babyish and somewhat asymmetrical. Lobules of ears adherent. Palate well formed. Nervous system, slight ptosis. Pupils: right, 5 mm., left, 4 mm.; outlines irregular; immobile to light and accommodation. Sight impaired. Hearing slightly impaired. Speech

Tremors of facial muscles and hands. Paresis of right arm and practically paralysis of left arm with some wasting and rigidity; paresis also of legs and she cannot walk. Coordination and station impaired. Superficial reflexes present. A. C. present. Tactile sensa-Knee-jerks very exaggerated. tion apparently normal. Deglutition easy. Heart and lungs normal; slight thickening of radial arteries. Tongue clean. Lateral incisors very small. Pubic hair present. (2) Mental: Power of attention very impaired. At times notices the slightest events and makes some incoherent remark regarding them; at other times dull and apparently stuporose. Comprehension always impaired. When excited she reacts quickly but wrongly. Does not really understand her surroundings; makes many mistakes of identity; fails to orientate. Memory grossly impaired; ideation very poor. Hears voices of people on the housetop and at times has illusions. Is excited, restless and noisy at times; at others lachrymose and apprehensive. When excited there is excess of bien être but no definite grandiose ideas. Is untidy; cannot dress herself, employ herself, or attend to any personal needs; is wet and dirty. Has no sense of propriety.

Progress. December 18.—Had a convulsive seizure, after which she was very collapsed. Temperature went up a little, and later she became very excited and confused. January 9, 1901.—Had seizures for nearly an hour; left limbs more convulsed than right; was rigid afterwards and did not respond mentally. January 19.—Up to the last forty-eight hours has been acutely excited; now much quieter but very confused. February 1.—Physical examination shows pupils rigid, a shade unequal, size 4 mm.; ptosis not so marked as on admission; A. C. not so definite; knee-jerks less brisk; marked wasting of thighs. March 1.—Seems quite unable to appreciate anything said to her; is unable to do anything for herself; mutters unintelligible words. March 20.—Had several convulsive seizures during 18th and 19th inst., and last night was very restless and talkative. June 14.—Rapid degeneration has ensued and she is now much emaciated. All day chews her sheets or grinds her teeth; at night is frequently noisy and restless. Had a seizure to-day. Does not understand anything said to her. July 4.—Had a succession of seizures and died at 6.40 p.m.

Post-mortem Examination.

July 5, at 3 p.m.—Body much wasted; no bedsores. Thighs flexed on trunk, legs on thighs, and left forearm on arm.

Skull cap, 3 to 5 mm. thick, somewhat dense and congested. Dura somewhat thickened and adherent to skull cap. Sinuses contain pale clot; in places adherent to walls. Pia-arachnoid markedly thickened and opaque, especially in the fronto-parietal regions; mid-line prefrontal adhesions well marked. There is very extensive thrombosis of the surface veins. On right side the great anastomotic vein (situated rather farther forward than usual), is completely plugged by an organising thrombus, as are several smaller veins opening into the superior longitudinal sinus in the central and occipital regions. The large transverse branch running backwards from the great anastomotic is less completely blocked. On left side this branch is entirely plugged, as are several smaller veins over the occipital cortex. The great anastomotic on this side is free.

The brain is typical of general paralysis; convolutions somewhat simple and markedly wasted, especially in the prefrontal region and in portions of the superior and inferior parietal lobules. Lateral ventricles very dilated and granular. Fourth ventricle shows large granulations throughout.

Pleuræ, a large number of firm adhesions. Bronehial glands, some enlarged and cascated. Lungs, right, whole lung studded with small caseating areas, base more affected than apex; left, in a similar condition but more marked, with a cavity, half an inch in diameter, at apex. Heart small and somewhat fatty. Slight atheroma about commencement of coronary arteries. Aorta shows small patches of atheroma, most marked at commencement. Liver enlarged, somewhat friable; gall bladder contains about twenty small gall stones. Spleen engorged. Kidneys, capsule somewhat thickened and adherent in places. Stomach, mucous membrane slightly engorged. Intestines (small and large), some patchy congestion, walls thickened, mucous membrane smooth and atrophied in places; no sign of old or recent ulceration. Uterus small. Other organs normal.

Weights of organs in ounces: Brain, 36; heart, $4\frac{3}{4}$; lungs, right, $19\frac{1}{2}$, left, $22\frac{1}{2}$; liver, $27\frac{1}{2}$; kidneys, right, 3, left, $3\frac{1}{4}$; spleen, $3\frac{1}{6}$.

Microscopical Examination.

Several of the central cortical areas were examined by the method of Nissl, and by the Heidenhain-erythrosin method. These exhibit changes typical of general paralysis. There is much thickening and congestion of the membranes, great congestion and thickening of the vessels generally and much neuroglia

proliferation; also marked destruction of the cortical nerve-cells and thinning of the pyramidal layer, especially in the frontal Unfortunately, however, the nerve-cells show changes most probably due to post-morten decomposition. They stain diffusely, though many of the cells (excepting their nuclei) are pale, and no Nissl bodies can be made out in any of the cells; not even in the larger ones. The nuclei stain very intensely and uniformly, being much darker than the cytoplasm of the The nerve-cells have this same appearance in all the cell. cortical areas examined, not merely in those most involved by the thrombosis of the surface veins. It is to be feared that no reliance can be placed on the finer changes seen in the nervecells. This is the more regrettable in view of the interest of the case, owing to the extensive thrombosis of the veins which had occurred. Although the autopsy was performed within twenty hours of death it is probable that post-morten decomposition progressed very rapidly owing to the condition of the cerebral tissues generally due to the thrombosis of the veins and to the state of the weather at the time (July).

Portions of the following cerebral cortical areas were examined by the methods of Marchi and by the Marchi ironalum Pal method: The right ascending frontal (top), right first frontal (middle and anterior), right and left Broca (pars triangularis), left second temporal (middle).

By the Marchi method, a few recently degenerated fibres are seen in all these areas. There is a considerable amount of darkly-stained débris in the perivascular lymphatics and contained in "carrier cells." The tissues were very brittle, and sections difficult to obtain.

By the Marchi iron-alum Pal method in the ascending frontal convolution there is considerable diminution of the tangential and superradial fibres with degeneration of those remaining; the interradials are diminished and degenerated; the radials less affected. In the prefrontal region all the fibres of the cross layers are practically absent and the radii much thinned and degenerated. In the temporal region the fibres are in a very similar condition, whilst in Broca's convolutions they are better but not so good as in the ascending frontal.

Case 8.

M. G., female. Age at onset of the disease about 14; at death, 21 years.

Family history.—Parents married at 22 (F.) and 20 (M.), 45

and had twelve children, of whom the first four were still-born or died shortly after birth. Patient was the sixth child. The tenth died of convulsions at 11 months and the eleventh child of "something the matter with her brain" at 3 months.

History and course.—Patient was always a delicate child, but was bright and intelligent, passing the seventh standard at 12 years of age. When about 13 or 14 she became melancholy and childish, also had some twitching of left arm and leg. She became progressively worse and was sent first to the London Hospital and then to Claybury Asylum in July, 1897, aged 18 years. She then had typical symptoms of general paralysis, marked failure of memory and reasoning power with some exalted delusions. Speech thick and slurred. Pupils unequal, irregular and reacting feebly to light. Tremor of tongue, facial muscles and hands; unsteady and spastic gait with exaggerated knee-jerks. There were typical signs of inherited syphilis and gray atrophy of both discs, left most (first noted July, 1897). Becoming gradually more demented and paretic, she died in December, 1899. She had no definite seizures but often complained of gnawing pains in left hand, side and leg; these attacks were accompanied by rise of temperature. Menstruation began at 13, and after being very irregular ceased at 17 years of age.

Post-mortem Examination (two and a half hours after death).

Body much wasted; no marks. Dura thick and tense owing to great excess of cerebro-spinal fluid. Pia opaque and thickened over frontal, parietal and upper temporal regions and adherent in places when stripped. Vessels at the base and sinuses healthy. Superior longitudinal sinus contains a little partly decolourised clot. The brain shows very definite atrophy of both frontal lobes, including the anterior two-thirds of the first frontal gyri in their mesial aspect (most on right side); also some wasting of the parietal convolutions behind the ascending parietal and of the upper temporal. The right hemisphere was almost completely stripped and shows the most obvious wasting in the prefrontal region, the first temporal and in the superior and inferior parietal lobules; to a less extent in Broca's convolution, the back of the first and second frontal and the lower fourth of the central convolutions. The upper three-fourths of the central convolutions and the occipital lobe are little wasted. Ventricles dilated. The walls of the lateral, third and fourth ventricles are studded with small granulations. Ribs brittle. Pleura, old adhesions at both apices. Bronchial glands enlarged. Lungs, right, upper lobe solid from pneumonia and has two cavities, the size of a hazel nut; left, several small cavities in upper lobe. Both lower lobes in a condition of tuberculous broncho-pneumonia; many small foci breaking down in right. Tubercle bacilli found. Heart small; coronary arteries healthy. Liver congested; capsule of part of left lobe thickened and opaque. Spleen large, tough and fibrous. Kidneys practically healthy. Uterus rather fibrous. Ovaries small and tough. All other organs healthy.

Weights of organs in grammes: Hemispheres, right, 400, left, 420; cerebellum, 145; heart, 187; lungs, right, 390, left, 470; liver, 843; spleen, 79; kidneys, right, 93, left, 87.

Microscopical Examination.

Cerebrum.—(1) Sections from the following cortical areas were stained by the method of Nissl and some of its modifications; also by the Heidenhain-erythrosin and other methods: Left ascending frontal (upper part), right paracentral, right and left Broca (pars triangularis), right and left extreme prefrontal, right superior parietal lobule, left first and second temporal (middle), left island of Reil, left hippocampal, right and left calcarine (anterior and posterior).

Central convolutions.—The pia where present is thickened, swollen and infiltrated with small round cells; its vessels are much congested and thickened. The vessels throughout the cortex are much engorged; there is great proliferation, especially of their adventitial and endothelial elements, and many show fairly well-marked hyaline fibroid change. Many of the smaller vessels show pseudo-aneurismal dilatations, and here and there minute hæmorrhages are seen in the perivascular spaces and occasionally into the surrounding tissues. There is some amount of leucocytosis. A few vessels, especially in the white matter, still present a fairly normal aspect. The pyramidal layer of nervecells is somewhat, though certainly not markedly, thinned. The small pyramids are diminished in number, and those remaining show all stages of acute and chronic degeneration, the majority being much swollen. Of the medium-sized and larger cells some are fairly normal in aspect, some shrunken and atrophied, many in scattered foci are swollen, and others in a condition of coagulative necrosis. Betz cells are numerous; some practically normal, except for slight swelling and chromatolysis; others exhibit more advanced destructive changes. The polymorphic

cells are generally little affected, except by swelling. There is a most remarkable hypertrophy and hyperplasia of the neuroglia throughout the gray and white matter, glia cells and fibrils being seen in all stages of formation. The proliferation is most marked in the immediate neighbourhood of the vessels, and the fibrillation most evident in the molecular layer of the cortex. Right and left Broca's convolutions show considerable thinning of the pyramidal layer and destruction, especially of the smaller cells. In the extreme prefrontal region there is much more diminution of the pyramidal layer and cellular destruction than in any other part examined. The right superior parietal and left first and second temporal convolutions are affected to a rather greater extent than are Broca's convolutions. The left hippocampal region and island of Reil show considerable destruction of the nerve-cells, but perhaps less than most of the other regions examined. In the calcarine areas the pyramidal layer is certainly diminished, especially in the "visuo-sensory" cortex, and the smaller cells show acute and chronic changes. outer layer of granules in the "visuo-sensory" cortex is diminished and the line of Gennari certainly thinned. inner layer of granules, the line of Baillarger and the polymorphic layer appear to be of about average thickness. The structural alteration in the vessel walls is about the same in all the regions of the cortex examined as it is in the central region, but the congestion of the vessels is the most intense in the central cortex and in the calcarine. The acute changes in the nerve-cells are also most marked in these regions. development is very great in every part of the cortex, but is perhaps most evident in the central, occipital and prefrontal areas.

- (2) Blocks from the following areas were stained by the Marchi method, and sections also further treated by the Marchi iron-alum Pal and other fibre staining methods: Right ascending frontal and paracentral, right and left Broca (pars triangularis), right second and left third frontal (middle), left first frontal (in front of middle), left extreme prefrontal, left island of Reil, left hippocampal, left supramarginal and angular, left upper occipital, and various parts of right and left calcarine areas.
- (a) In Marchi stained specimens all these regions show recent degeneration of at least a few of the radial fibres, and in some areas a considerable number of fibres are so affected. There is a good deal of Marchi stained débris in the perivascular spaces,

in the vascular endothelium, and in "carrier cells" contained in the perivascular spaces, intervascular areas and in the pia. In the calcarine cortex and white matter in the neighbourhood of the calcarine fissure and posterior horn of the lateral ventricle, many fibres of the optic radiations, and of the system of long and short association fibres show recent degeneration.

(b) The Marchi iron-alum Pal preparations show an almost entire absence of all the cross layers of fibres in all the regions examined, with much degeneration also of the radial fibres. In the occipital and central areas, however, a few greatly degenerated tangential and superradial fibres remain, the interradial and radial fibres being in these regions less affected than in other parts of the cortex. The occipital cortex is generally better than the central, but the line of Gennari is distinctly less prominent than normal. Both Broca's convolutions are about equally affected and appear to be rather less involved than is the prefrontal area though more than is the central.

In this case much difficulty was experienced in staining the cortical nerve-fibres, although various methods were tried. This difficulty was probably due to the condition of ædema of the tissues. The glia cells and fibres stained remarkably well in Pal preparations, and the nerve-fibres in other parts of the nervous system stained satisfactorily.

The left internal capsule and basal ganglia.—Sections through the entire length of the internal capsule with the surrounding parts at various levels were stained by the Marchi and Marchi-Pal methods. A considerable number of recently degenerated fibres are seen in both the anterior and posterior limbs of the internal capsule corresponding in position to those of the fronto-thalamic and cerebellar fibres, to those of the motor system and optic fibres. Some few fine fibres of the optic thalamus are also seen to be degenerated. Other degenerated fibres of the globus pallidus will be referred to below. Sections of a portion of one lenticular nucleus and of one entire optic thalamus stained by Nissl's method show much congestion of the vessels, thickening of their walls, and some capillary hæmorrhages, together with recent glia proliferation. All the groups of nerve-cells are grossly affected, exhibiting marked destructive changes, especially in the optic thalamus, with much pigmentation of the cells.

The left retina, stained with Nissl's and polychrome blue. The only noticeable change is that many of the ganglion cells appear to be greatly disintegrated. Some still remain of fair

shape and containing definite chromophile elements; others are much broken down, consisting merely of nuclei with stained granules adhering to them.

The optic nerves.—In longitudinal and cross section, stained by the methods of Marchi, Marchi-Pal, Stræbe, Van Gieson, and by hæmotoxylin and eosin. Both nerves are much atrophied, the left being especially small; their sheaths are greatly thickened, and there is much increase of connective tissue. The vessels are very congested and their walls thickened. Great numbers of leucocytes are seen and some cells of similar appearance to the hypertrophied glia cells of the cerebral cortex. No nerve-fibres showed the Marchi reaction. In Stræbe specimens the axis cylinders often appeared to be swollen and irregular. In the left optic nerve very few fibres could be made out, but in the right nerve the fibres are much more numerous.

The optic tract.—A very large number of sections (practically serial) were made of Marchi-stained blocks of the left optic tract, the crus cerebri, corpora geniculata, the pulvinar, and the body of the optic thalamus. Not a single fibre of the optic tract along the whole of its course showed signs of recent degeneration, but in sections stained by the Marchi-Pal method there appeared to be considerable diminution of the fibres of the tract itself, and of the fibres entering and leaving the lateral geniculate body and the pulvinar.

The caudate cerebellar system of fibres.—In the above series of Marchi-stained sections, together with those of the internal capsule, crus and pons, an interesting tract of degenerated fibres was traced downwards from the neighbourhood of the internal capsule to the crus and upper part of the pons. The degenerated fibres first appear as definite bundles of fine and medium sized fibres, situated in the most internal part of the globus pallidus, immediately external to the internal capsule in the neighbourhood of its genu. It would seem probable that they are axones, cut transversely, of the cells of the over-arching caudate nucleus. The degenerated fibres are seen in a corresponding position lower down. Still lower they begin to appear on the inner side of the commencing crusta of the crus. Between the crusta and the substantia nigra they lie in the position of the caudate cerebellar fibres. In this situation also many very fine (degenerated) fibres are seen, which are probably terminals ending about the cells of the substantia nigra and possibly of the red nucleus. In the lower part of the crus the

degenerated fibres are less numerous; these fibres most likely end lower down about the cells of the nucleus pontis, many fine black stained dots being seen in the neighbourhood of these cells. Some fibres of the superior cerebellar peduncles also appear to be affected. This degenerated tract of fibres would seem to belong mostly to the caudate cerebellar system, connecting the caudate nucleus with the cerebellum chiefly by way of the nucleus pontis, though some may possibly constitute part of the striothalamic tract of Edinger ending in the cells of the substantia nigra.

In the crus a fair number of pyramidal fibres and a few fibres of the fronto-cerebellar and temporo-occipital cerebellar systems show recent degeneration.

The pons and medulla, at various levels stained by methods of Marchi, Marchi-Pal and van Gieson. The most obvious recent degeneration occurs in the fibres of the pyramidal bundles in the pons and of the anterior pyramids in the medulla. Some few fibres of the fillet, of the posterior horizontal bundles, of the superior cerebellar peduncles, and of the restiform bodies, also exhibit recent degeneration. It is doubtful if any of the cranial nerves show recent degeneration by the Marchi method, although numerous black droplets are seen in the spaces around the fibres, the axis cylinders of which present a normal aspect in van Gieson preparations.

The medulla stained by Nissl's method. The membranes are thickened, and the vessels generally congested and their walls thickened. There is a fair amount of neuroglia proliferation. The large motor cells of the twelfth nerve nucleus and of the nucleus ambiguus, the cells of the tenth sensory nucleus, of the lateral nucleus, and of the posterior column nuclei, show in general some swelling and chromatolysis, but few exhibit advanced destructive changes and many are practically normal.

The cerebellum.—The upper and lateral surfaces of one hemisphere stained by the Nissl, Marchi and Marchi-Pal methods. There are distinct acute and chronic degenerative changes in the Purkinje's cells with some thinning of the molecular layer. There is recent degeneration of a number of the projection fibres, and diminution and degeneration of the cross system of fibres.

The spinal cord.—(1) The following segments stained with Nissl's and with polychrome blue: C. 4, C. 5, D. 2, D. 6, D. 9 and L. 3. The condition of the membranes, vessels and neuroglia is much the same as in the medulla. The anterior horn cells are usually little changed, having good processes (which can often

be followed to their third or fourth divisions) and well preserved Nissl-blocks. Some cells show chromatolysis, and often the cells contain a considerable amount of yellow pigment. A few cells exhibit swelling, displacement of the nucleus, and more advanced destructive changes. The cells of Clarke's column are perhaps more affected than those of the anterior horns.

- (2) Blocks from the following levels by the Marchi method: C. 4, C. 5, C: 7, D. 3, D. 8, L. 4 and S. 1, showed recent degeneration of a considerable number of fibres of the crossed (more on one side) and of a few fibres of the direct pyramidal tracts. Some scattered fibres are also involved in the remainder of the antero-lateral, and many in the posterior columns. A few fibres of some of the anterior and posterior roots appear to be similarly affected.
- (3) Sections from the following segments stained by the methods of Pal and van Gieson: C. 3, C. 4, C. 5, C. 7, D. 3, D. 8, L. 3, L. 4, L. 5 and S. 1. There is fairly well-marked sclerosis in the crossed pyramidal tracts throughout, and slight sclerosis in the direct pyramidal tracts in the upper levels. There is definite though not very marked sclerosis in the posterior columns at all the levels examined, affecting only the exogenous systems of fibres. There is also some sclerosis of the entering posterior roots.

The posterior root ganglia.—The sixth cervical, seventh dorsal and first lumbar stained with Nissl's and with polychrome blue. The preparations are fairly satisfactory, most of the cells are practically normal in appearance; a few show large clear vacuoles, some are excessively pigmented. Around the most degenerated cells there is marked evidence of proliferation of the capsular elements. The vessels are much congested, and minute hæmorrhages are occasionally seen.

Case 9.

F. C., male. Age at onset of the disease about 12; at death, 18 years.

Family history.—Patient was the youngest of twelve children, five of whom died in infancy. One brother had "fits and paralysis" and died in Earlswood Asylum, aged 19 years. Mother died of phthisis and a sister has phthisis.

History and course.—Patient was a sharp boy and passed the sixth standard at 12 years of age. Soon after this his memory

was noticed to be getting defective, and he was sometimes strange in his actions; was able to follow his occupation at a wine merchants, however, till he was 16 years of age, when he became more dull. Was sent to the infirmary and finally to Claybury Asylum in December, 1899. He ran the typical course of general paralysis, and died in December, 1900. He is said to have drank to some extent in the earlier part of his illness.

Mental.—The first symptoms noticed were failure of memory, some loss of reasoning power and confusion of ideas. He then developed some exalted notions. His ideas of personal identity, time and place became more impaired, but he remained for some time happy, emotional, and full of childish grandeur. During the last few months of his life he was extremely demented and was wet and dirty in habits.

Physical.—He was of small and stunted growth. "At 17 years looked like a boy of 12." He had typical signs of congenital syphilis. Speech, much slurring and elision. Marked tremor of facial muscles, tongue and hands. Pupils large, R.>L.; both irides irregular, reaction very sluggish to light and (?) to accommodation. Walked with a wide base and latterly became very unsteady. Knee-jerks + + +. No A. C. Left wrist tap +, jaw jerk + +. Before death he became very emaciated and helpless. One convulsive seizure only is recorded on February 24, 1900.

Post-mortem Examination.

Twenty-four hours after death, body having been in the cold chamber. Body extremely emaciated. No bedsores.

Skull cap greatly thinned in the region of the coronal suture, and anterior to this on the left side, externally, the coronal suture is very prominent, and the interparietal suture can be felt. The metopic suture is closed and the frontal eminences Dura adherent to coronal and parietal very prominent. sutures; external appearance natural. Subdural fluid in great excess. Pia-arachnoid opaque over the whole brain, most over the anterior two-thirds. Sub-arachnoid fluid in some excess. Vessels generally natural. The encephalon is exceedingly soft; is typical of general paralysis; lateral ventricles greatly dilated; fourth ventricle very granular. Ribs natural. Lungs healthy. Heart much wasted and somewhat dense. In the ascending portion of the aorta are a few pin-points of early atheroma. Liver dense and contains a large amount of fibrous tissue, chiefly in the region of the portal canals. Spleen extremely dense,

difficult to lacerate. Kidneys slightly dense. Stomach slightly congested. Small intestine in a condition of patchy congestion. Genital organs, "if anything, smaller than those of a new-born babe"; left testicle the size of a haricot bean, right that of a broad bean.

Weights of organs in grammes: Encephalon, 1,105; cerebellum, pons and medulla, 138; heart, 120; lungs, right, 150, left, 130; liver, 700; spleen, 60; kidneys, 70 each.

Microscopical Examination.

Cerebrum.—(1) Sections from the following areas stained with Nissl's and polychrome blue, and by the Heidenhain-erythrosin method: Right and left ascending frontal (top), right and left Broca (pars triangularis), right first frontal (anterior), left extreme prefrontal, right superior parietal (middle), left first temporal (middle), right and left calcarine (posterior).

Ascending frontal convolutions.—Pia much thickened, swollen and infiltrated, its vessels very congested. Vessels throughout greatly congested, and there is much proliferation of all the elements of their coats, whilst the smaller vessels especially show a considerable amount of hyaline change. Some hæmatoidin pigment is occasionally seen in the lymph spaces. The pyramidal layer of nerve-cells is markedly thinned, especially on the right side on the flat surface of the convolutions, and to a less extent on the sides and bottoms. The small and medium sized pyramids are much diminished in number, and those remaining are in all stages of acute and chronic degeneration, the former changes predominating. The larger pyramids and Betz cells are much less affected; some are fairly healthy, others show great swelling of the cell body and nucleus with advanced chromatolysis, breaking down of the cellular reticulum and vacuolation. A few of the larger and medium sized pyramids appear to be in a condition of coagulative necrosis. There is a considerable amount of neuroglia proliferation, but most of the neuroglia cells appear to be recently formed, and there is little fibrillation even in the outer layer of the cortex. Broca's convolutions show similar changes, the destruction of the pyramidal cells being even more marked. Acute changes are very evident. Glia proliferation considerable, but no great amount of fibrillation. In the prefrontal regions the nerve-cell destruction is more advanced than in any other part examined. There is great loss of nerve-cells in the pyramidal layer

(especially of the smaller cells) which is much thinned. Vessels greatly congested and thickened, and the neuroglia replacement considerable. In the superior parietal lobule and first temporal convolution the changes are more marked than in the ascending frontal but less than in the prefrontal. In the calcarine areas most of the nerve-cells show swelling and chromatolysis, but the amount of destruction is nothing like equal to that seen in other regions of the cortex. Vessels greatly congested and there is much neuroglia proliferation.

- (2) Blocks from the following areas were stained in Marchi's fluid, and sections further treated by the iron-alum or ammonium molybdate Pal method: Right and left ascending frontal (leg and arm areas), left extreme prefrontal, right and left Broca (pars triangularis), right and left superior parietal (middle), right first and left second temporal (middle), right and left calcarine (anterior and posterior).
- (a) By the Marchi method, a large number of radial and some interradial fibres show recent degeneration in all the above regions, but such degenerated fibres are most numerous in the central convolutions and in the calcarine areas. Many "carrier cells" are also seen containing darkly stained particles, especially in the most degenerated portions. The endothelial cells in many instances appear to contain similar particles. The sections of the calcarine area are large and include the white matter around the posterior horn of the lateral ventricle; many recently degenerated fibres are seen in this area; some are probably fibres of the optic radiations, some short association fibres of the occipital gyri, whilst others belong to the bundles of long association fibres, the tapetum and fasciculus longitudinalis inferior.
- (b) By the Marchi-iron-alum-Pal method. Ascending frontal convolutions.—Tangential fibres generally fairly abundant, especially the fine and medium fibres, although here and there some coarse ones remain; in patches much diminished and degenerated. Superradial fibres affected to the same, or to a rather greater extent. Interradial generally good and radial little involved. In Broca's convolutions the cross layers are still fairly abundant but show more evidence of degeneration; the radii are also more tortuous and broken in appearance. The left side is more affected than the right. In the extreme prefrontal region there is almost complete destruction of all the cross layers, whilst the radial fibres fall very short and are much degenerated. The superior parietal lobules show changes about on a par with those in Broca's convolutions, the left being

more affected than the right side. In the temporal regions the tangentials are very scanty and degenerated, the superradials almost absent, the interradials greatly diminished, and the radials short and curly. In the calcarine areas the tangentials and superradials are, on the whole, abundant, though diminished and degenerated in places. The line of Gennari is good, and the radii practically normal. Some of the above areas were also examined by the method of Cox, without, however, revealing anything worthy of note.

The internal capsule.—The anterior limb and part of the posterior limb, by the Marchi method, shows recent degeneration of a large number of fibres of the fronto-thalamic, cerebellar and motor systems.

The left crus.—By the Marchi method. A large number of pyramidal fibres in the crusta and a considerable number of fronto-cerebellar and caudate cerebellar fibres show recent degeneration, as do scattered fibres in other parts of the crus, especially in the neighbourhood of the red nucleus.

The pons.—Various levels by the Marchi method. Recent degeneration is seen in some few fibres of the posterior longitudinal bundles, of the fillet, and in the decussation of the superior cerebellar peduncles; but by far the most marked degeneration is in the fibres of the pyramidal bundles. A very large number of these latter fibres are affected, in great contrast to the transverse pontine fibres which have almost entirely escaped.

The medulla.—(1) Various levels by the Marchi and Marchi-Pal methods. A very large number of recently degenerated fibres are seen in the anterior pyramids and a few scattered fibres elsewhere. There is fairly well-marked sclerosis of the anterior pyramids. It is doubtful if any of the fibres of the cranial nerves show recent degeneration in any part of their intrapontine or intramedullary course, excepting perhaps the fifth and the tenth. (2) By Nissl's method and the Heidenhain-erythrosin method most of the cells of the twelfth nucleus are practically healthy, whilst others show various stages of acute or chronic degeneration. Many of the cells of the posterior column nuclei are swollen and show destructive changes. The vessels are very congested, but their walls not much thickened. The neuroglia proliferation is considerable.

The cerebellum.—A portion of the upper part of the left hemisphere and the dentate nucleus by the following methods: Nissl, Heidenhain-erythrosin Cox, Marchi and Marchi iron-alum

Pal. (1) In Nissl preparations, there is diminution in number and degeneration of the Purkinje cells with some thinning of the molecular layer of the cortex. Many of the cells of the dentate nucleus are swollen and vacuolated. Membranes thickened and vessels generally congested. (2) In Marchi specimens, a considerable number of projection fibres show recent degeneration as do some of the short association fibres of the foliæ. In the neighbourhood of the dentate nucleus a large number of fibres entering or leaving this structure show recent degenerations. The Pal preparations show some diminution and degeneration of the tangentially coursing fibres of the cerebellar cortex.

The spinal cord.—(1) Sections from the following levels stained with Nissl's and polychrome blue and by the Heidenhain-erythrosin method: C. 2, C. 3, C. 6, D. 9, D. 10, L. 1, L. 4. Many of the anterior horn cells are practically normal; some show slight acute and others much more advanced destructive changes. The cells of Clarke's column are only slightly if at all affected. There is considerable thickening of the membranes, congestion of vessels and neuroglia proliferation.

(2) The following levels by the Marchi, Marchi-Pal and van Gieson methods: C. 3, C. 8, D. 1, D. 3, D. 4, D. 6, D. 8 and D. 10; L. 1, L. 2, L. 5 and S. 2. Many recently degenerated fibres are seen in the direct and crossed pyramidal tracts; also in less numbers scattered generally in the rest of the anterolateral areas and in the posterior columns. A few fibres of some of the anterior and posterior roots are also affected. There is fairly well-marked sclerosis of the crossed pyramidal tracts and slight sclerosis of the direct pyramidal tracts in the upper levels. Some sclerosis is seen in the posterior columns throughout, but it is slight in the upper levels and not at all marked in the lower levels of the cord. There is no distinct sclerosis of the anterior or posterior roots near their union with the cord.

Case 10.

S. S., female. From Colney Hatch Asylum. Admitted June, 1896; died May, 1900. Age at the onset of the disease unknown, probably 19 or 20; at death, 25 years.

History and course.—Patient's father and mother died young; she had no friends, and little history could be got. She was probably an illegitimate child. She seems to have been of fair intelligence; passed the fifth standard, and was afterwards

employed in domestic service. At one time it appears that she did not lead an altogether steady life. She had typical symptoms of general paralysis; characteristic speech, marked tremors, unequal and sluggish pupils, staggering gait, absent knee-jerks and increasing paresis and dementia. She was usually depressed and had some distressing delusions. The disease progressed slowly at first but latterly she had many convulsive seizures and attacks of stupor with rise of temperature. Ultimately she became extremely demented and helpless. The central incisors were peg-shaped. She did not menstruate for at least the last four years of her life.

The notes of the post-morten examination obtained are rather scanty. The essential features are that the brain was small and characteristic of general paralysis. Soft membranes thickened and opaque over the frontal regions, and to a less extent over the parietal and upper temporal areas; there were marked midline prefrontal adhesions. Convolutions grossly wasted in the above areas, especially in the prefrontal. Lateral ventricles Fourth ventricle granular. dilated and granular. spinal fluid in great excess. Right hemisphere weighed 141 and left 14½ ounces. Pons, medulla and cerebellum, 4½ ounces. the apex of the right lung were two or three tubercular cavities. There was chronic dysenteric affection of the lower one and a half feet of the colon, and signs of acute dysentery involving the lower two or three feet of the ileum.

Microscopical Examination.

Cerebrum.—(1) Sections from the following areas stained with Nissl's and with polychrome blue, and by the Heidenhain-erythrosin method: Left ascending frontal and right ascending parietal (at and near the top), right and left Broca (pars triangularis), left second frontal (posterior), left extreme prefrontal, right first and left second temporal (middle), right superior parietal (middle), right and left calcarine (posterior).

Central convolutions.—Pia considerably thickened and infiltrated. Vessels generally congested; there is a good deal of proliferation of the elements of their walls and a fair amount of hyaline change. Neuroglia proliferation is considerable, but much of this appears to be recent and there is not much fibrillation. The pyramidal layer of nerve-cells is somewhat thinned. The small pyramids are diminished in number; some are fairly healthy, others show all stages of chronic and acute change. The medium and larger pyramids and Betz cells are on the whole

less affected, but some show chronic atrophy and others swelling with peripheral chromatolysis. In the ascending parietal the changes are perhaps more pronounced and older than in the ascending frontal. Broca's convolutions show a relative increase in thickness of the molecular layer of the cortex with considerable neuroglia proliferation and fibrillation. The pyramidal layer is thinned and the smaller pyramids diminished, the remainder being mostly very degenerated. The larger pyramids are also much degenerated, some show acute change, especially on the left side; scattered foci on this side also are almost entirely denuded of cells. Some of the smaller veins of the pia on the left side are blocked by organising thrombi. The second left frontal convolution (posterior) is at least as much involved as Broca. The left extreme prefrontal region is more affected than any other part examined, there being great thinning of the pyramidal layer with much destruction of the cells and neuroglia replacement. In the temporal regions and superior parietal lobule there is as much or more nerve-cell destruction as in Broca's convolutions, but less than in the extreme prefrontal regions. The temporal is more affected than the parietal, and in the former on both sides some small veins of the pia contain organising thrombi. In the calcarine areas there is considerable destruction of the smaller pyramidal cells especially, many showing acute changes. There is much neuroglia proliferation and some fibrillation in the outer layer. The vessels generally show about the same amount of structural change in all the areas examined; they are most congested in the calcarine, central and temporal regions.

- (2) Blocks from the following areas were stained in Marchi's fluid, and some sections further treated by iron-alum or ammonium molybdate Pal method: Left ascending frontal and right ascending parietal (top), left Broca (pars basilaris and pars triangularis), left extreme prefrontal, right third frontal (middle and anterior), left first temporal (middle), right superior parietal (middle), right calcarine (anterior and posterior).
- (a) By the Marchi method. A considerable number of recently degenerated fibres are seen in the central and calcarine areas, and a lesser number in the other regions. There is much darkly stained débris contained in "carrier cells" and in some cells of the vascular endothelium.
- (b) By the Marchi iron-alum Pal method. Central convolutions.—Tangential fibres diminished generally, the coarse fibres practically absent, but in places an abundance of fine and

medium fibres remain. Superradial are less numerous and more degenerated. Interradial and radial are good. There is great vascularity, and from certain pale areas the upper cross fibres are entirely absent. The cross fibres are less abundant and more degenerated in the ascending parietal than in the ascending frontal. Left Broca, pars basilaris.—The horizontal layers of fibres are on the whole more affected than in the ascending frontal, especially in patches, but they are still abundant in places. Pars triangularis shows a great contrast to the last, the cross layers being very greatly diminished and degenerated. Tangentials almost absent, superradial and interradial also, and the radials thinned and broken in aspect. Right third frontal (middle and anterior) is in the same (or even in a worse) state as regards its fibres as is the pars triangularis of left Broca. In the left extreme prefrontal no fibres are seen in the position of any of the cross layers, excepting a few greatly degenerated deeper interradials; the radials are thin, broken looking and stain badly. In the temporal region the fibres are involved to about the same extent as in the pars triangularis of Broca, excepting that the radii are better. The superior parietal shows practical absence of the tangentials and superradials; the interradials are thinned and degenerated, but the radials are fair. In the calcarine area there is great congestion of the pia and some sub-pial extravasation along the calcarine fissure; also a few punctiform hæmorrhages in the cortex. The fibre degeneration is very patchy in character; in places the cross fibres and radii are practically normal, in other places all the cross fibres are much diminished. In this case the neuroglia cells and fibres stain very well by the Marchi iron-alum Pal method.

The cerebellum, by the methods of Nissl, Marchi and Marchi ammonium molybdate Pal, shows some thinning of the molecular layer and degeneration of the Purkinje cells, recent degeneration of a few projection fibres, and some diminution of the cross fibres of the cortex.

The crus, by Nissl's method, shows chiefly much pigmentation of the cells of the oculo-motor nuclei, and of the upper nucleus of the fifth, with some degenerative changes in these cells.

The medulla at two levels by the Nissl and Heidenhain-erythrosin methods. There is little change in most of the cells of the cranial nerve nuclei examined or in the cells of the posterior column nuclei; a few show fairly advanced chronic and acute changes. Granulations in the floor of fourth ventricle are very prominent. Vessels considerably congested and thickened, and there is much recent neuroglia proliferation.

The pons and medulla, at various levels by the Marchi and Marchi-Pal methods. There are a fair number of recently degenerated fibres in the pyramidal bundles of the pons and in the anterior pyramids of the medulla; also a few scattered fibres elsewhere. No recent degeneration is shown by the Marchi method in the fibres of any of the cranial nerves. There is some sclerosis in the neighbourhood of the posterior column nuclei in the lower levels of the medulla, as also in Goll's column, particularly in the upper levels of the spinal cord. The anterior horn cells in the upper part of the spinal cord show some chronic and acute degenerative changes by Nissl's method. The remainder of the spinal cord was not obtained.

Case 11.

E. B., female. Age at the onset of the disease, 12; at death, 16 years.

Family history.—Parents married at 20 years of age. Father died of phthisis. Mother had definite signs of syphilis. There were seven pregnancies, two of which resulted in miscarriages. Three children died young of meningitis. The only now surviving child has typical signs of congenital syphilis. Patient was the fourth child.

History and course.—Patient never seems to have been very bright, but went to school for six years. She developed symptoms of mental disorder at 12 years, and was sent to Darenth Asylum at 14 years of age. She ultimately became extremely demented and paretic, with other signs of general paralysis. She had typical signs of congenital syphilis. She had no definite convulsive seizures. She never menstruated.

Post-mortem Examination.

Post-mortem examination showed great thickening and opacity of the pia arachnoid over nearly the whole of the cerebral hemisphere with marked wasting of the convolutions and great excess of cerebro-spinal fluid. Lateral ventricle greatly dilated and granular. Right hemisphere weighed 346.7 and left 318.4 grammes; cerebellum and pons, 113.2 grammes. Lungs showed broncho-pneumonia. Heart, soft and friable, weight $4\frac{3}{4}$ ounces. Liver and spleen soft. Uterus and ovaries very small. Body very emaciated.

Microscopical Examination.

The cerebrum.—(1) Sections from various parts of the ascending frontal and parietal and paracentral convolutions, stained by Nissl's and by Haidenhain's method, show thickening of the pia and some congestion of the vessels. The vessels generally are fairly prominent and many are congested. There is considerable proliferation of the elements of their walls, the arterioles and capillaries being on the whole less affected than are the medium sized vessels. The pyramidal layer of nervecells is somewhat thinned and the smaller cells especially diminished in number; some are very irregularly arranged and many are very degenerated. The larger pyramids and Betz cells are on the whole less affected. There is considerable glia proliferation and some fibrillation in the outer layer. Sections from the third frontal convolutions by Nissl's method show more destructive changes in the nerve-cells than do the central convolutions, whilst in the hippocampal and calcarine regions these changes are less marked. The nerve-cells generally tend to stain rather diffusely, and probably are in a condition of early post-mortem change. Little attention was, therefore, paid to the finer alterations in the nerve-cells in this case.

(2) Blocks from the right paracentral, right and left Broca's, and the left calloso-marginal convolutions, and the hinder part of the corpus callosum were stained in Marchi's fluid. A few recently degenerated fibres are seen in each of these regions. This case had been partially investigated by a previous worker before passing into my hands, and sections from various areas were stained by the Pal method. They show an almost complete absence of the horizontal systems of nerve-fibres in all the regions examined, but the fibres remaining stain so badly that I fear but little value can be attached to the specimens. They have not, therefore, been considered.

The pons and medulla, at various levels by the Marchi, Marchi-Pal and carmine Weigert methods, show recent degeneration of a few fibres of the pyramidal bundles and possibly of the fillet; also of the anterior pyramids in the medulla, which latter are somewhat sclerosed. No recent change could be seen in any of the cranial nerves.

The spinal cord.—C. 2, C. 5 and D. 10, by Nissl's and Heidenhain methods. The anterior horn cells are mostly practically healthy, but some show destructive changes. Vessels generally congested. Membranes thickened and there is some

neuroglia proliferation. C. 3, C. 5, D. 4, D. 9 and D. 11, by the Marchi method, showed a few recently degenerated fibres practically confined to the crossed pyramidal tracts. C. 3, C. 5, C. 6, D. 4, D. 5, D. 7, D. 9 and S. 2, by Pal's method, showed fairly well-marked sclerosis in the crossed and less definite sclerosis in the direct pyramidal tracts. There is little if any sclerosis of the posterior columns or of the anterior or posterior nerveroots.

The right and left vagus nerves from the neck, stained by Marchi's method, exhibit no definite evidence of recent degeneration by this method.

The heart muscle, pectorals and diaphragm, stained by Marchi's method, show no fatty change and little diminution of striation.

The ovaries, by the Marchi and van Gieson methods, appear to be normal except for under development. There are a fair number of follicles, but all those seen (excepting one which is approaching ripeness) are exceedingly small.

Case 12.

B. L. Age at the onset of the disease, 18; at death, 22 years. History and course.—Father was intemperate, and mother had signs of syphilis. Patient was the youngest of a large family. At 20 years of age he was undersized and had definite signs of congenital syphilis. He was never very bright, but was able to earn his living for a time as a stable help. The disease ran a typical course, and before death the patient was extremely demented and helpless. There was a rather indefinite history of seizures.

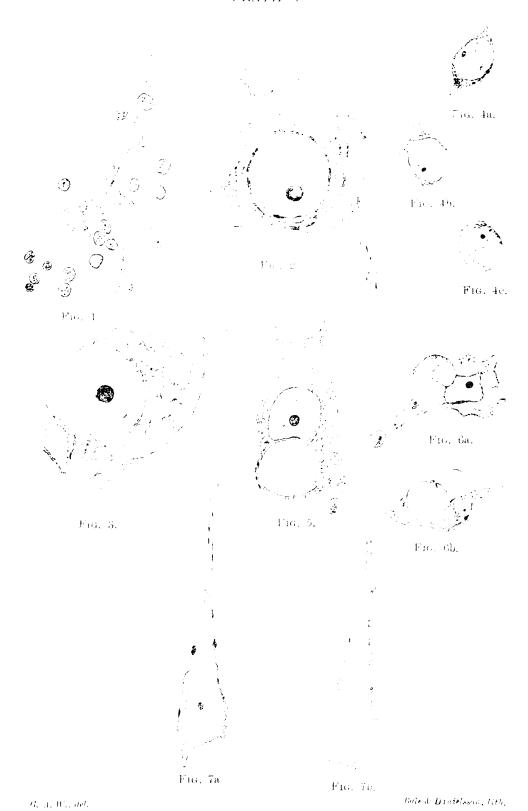
The post-morten examination was performed by Dr. Mott, who states that the brain presented all the usual signs of general paralysis. Only the central convolutions from one side were preserved for microscopical examination.

Microscopical Examination.

Sections from various parts of the central convolutions, stained with Nissl's and polychrome blue, with logwood and eosin and by the Heidenhain method. The pia is considerably thickened and infiltrated; its vessels somewhat engorged. Many of the vessels in the gray and white matter are moderately congested. The vessel walls in some instances show thickening

of their adventitia and proliferation of their endothelial elements, but many vessels are seen whose walls are apparently The pyramidal layer of nerve-cells is practically normal. thinned but not markedly so. The small pyramids are certainly diminished in number and their arrangement is irregular. The remaining cells show profound degenerative changes, mostly of a chronic nature, many being represented only by what are practically free nuclei. Many of the larger pyramids and Betz cells are similarly affected, but the destructive changes in these are seldom so pronounced. A few hypertrophied neuroglia cells are seen and there is much recent neuroglia proliferation, but little attempt at fibrillation, even in the molecular layer of the cortex. Owing to the tissues having been hardened in formalin and then placed in spirit, no Marchi specimens nor any satisfactory staining of the finer nerve-fibres could be obtained. This brief description is merely given because the case illustrates the possibility of profound degenerative changes occurring in the nerve-cells with only a moderate affection of the vessels. Clinically, nevertheless, the case was typical of general paralysis.

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To face prop. 725.

PLATE I.

Types of change affecting the nerve-cells. All the drawings were made from cells of the cortex cerebri, excepting Fig. 5, which is a cell of the dentate nucleus of the cerebellum.

- Fig. 1.—Shows fairly advanced chronic degeneration.
- Fig. 2.—Swelling of the cell body and nucleus, with chromatolysis affecting especially the periphery of the cell.
- Fig. 3.—A more advanced stage of a similar change; chromatolysis with destruction of the cellular reticulum and displacement of the nucleus.
 - Fig. 4. a, b, c—Stages of a similar change affecting smaller cells.
- Fig. 5 and 6.—Chromatolysis and vacuolation, with much breaking down of the cellular reticulum in Fig. 6 a.
 - Fig. 7. a and b.—Coagulation necrosis.
 - 1 Leitz oil immersion lens and Nr. 4 ocular.

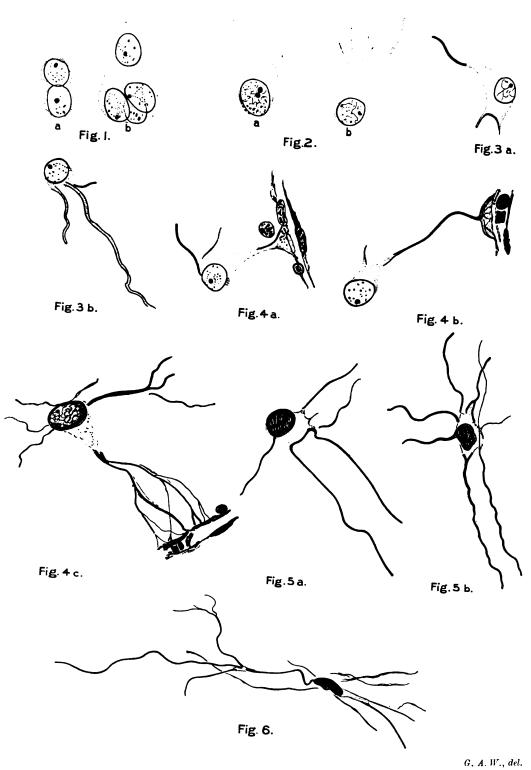
PLATE II.

Phases in the development of neuroglia cells and fibrils.

The drawings are all from cells of the cortex cerebri stained by the Heidenhain-erythrosin method. They appear somewhat diagrammatic, partly from being drawn in one plane and partly owing to the process of reproduction, but are really little more so than the preparations show. The parts shaded gray are stained pink in the specimens.

- Fig. 1. a and b.—Dividing neuroglia nuclei surrounded by an indefinite amount of protoplasm.
 - Fig. 2. a and b.—Protoplasmic processes more definitely formed.
- Fig. 3. a and b.—Commencing condensation of protoplasmic processes producing darkly staining fibrils.
- Fig. 4. a, b and c.—Show mode of attachment of the processes to a vessel wall. In a and b there is apparent partial differentiation of the protoplasm of the "foot" into fibrils.
- Fig. 5. a and b.—Further development of fibrils. The nucleus is more darkly-stained and in b the pink-stained protoplasm somewhat less in amount; a shows a "recurved" and b "bifurcated" fibrils.
- Fig. 6.—The protoplasm is almost entirely differentiated into fibrils and the nucleus is shrunken and stains darkly.

1 oil immersion lens and Nr. 4 ocular.



The Pathology and Morbid Histology of Juvenile General Paralysis.

To five p. 7.26.

THE COAGULATION-TEMPERATURE OF CELL-GLOBULIN, AND ITS BEARING ON HYPER-PYREXIA.

BY W. D. HALLIBURTON, M.D., F.R.S.,

F. W. MOTT, M.D., F.R.S.

It is well known that there are various factors that influence the temperature of heat-coagulation of proteid substances. Among these the rate of the rise of temperature is one of some importance. This was clearly demonstrated in the work of Corin and Ansiaux, and of Hewlett. These observers showed in connection with serum and eggwhite respectively that if the temperature is maintained long enough below the point at which heat-coagulation is usually stated to occur, not merely opalescence but the formation of flocculi will take place.

In performing the process of fractional heat-coagulation with extracts of various organs and tissues, one of us 3 has shown that in nearly all of them a proteid is present that coagulates at an extremely low temperature, which varies in different cases from 45° to 50° C. This proteid is a globulin, and has been variously named. Thus in muscle Hammarsten terms it musculin, and one of us has named it para-myosinogen; in liver cells it has been called hepato-globulin; in extracts of nervous tissues, neuro-globulin; in extracts of lymph-cells, cell-globulin, and so on. There can be very little doubt that such a globulin is characteristic of protoplasmic structures, and even if it is not absolutely the same proteid in all cases, the term cell-globulin may be provision-

Bulletin de l'acad. roy. de Belgique, xxi., 3, 1891.

Journ. of Physiol., xiii., 494, 1893.

See "Schäfer's Text-Book of Physiology," vol. i., Art., "The Chemistry of the Tissues and Organs," by W. D. Halliburton.

ally employed in a general sense to indicate that cells, as a rule, yield to saline solvents a proteid with characteristically low coagulation-temperature.

One might, however, object that the behaviour of saline extracts of cells does not necessarily teach us the condition of the proteids as they are actually present in the complex we call protoplasm. In view of such a criticism we attach special importance to the researches subsequently carried out by Brodie and Richardson, and later by Vernon. These investigations show in the case of muscle that the shortening which occurs in the process of heat-rigor is not a single one, but takes place in a series of steps; the temperatures at which these steps occur are the same as those at which the individual proteids separate out during the fractional heat-coagulation of an extract of muscular tissue. Thus in mammalian muscle the two principal shortenings occur at 47° and 56° C., the coagulation-temperatures of the two principal muscular proteids. In frog's muscle there are three steps at 40°, 47°, and 56° C. respectively, which correspond to the three proteids that can be separated out in a saline extract of this variety of muscular tissue.

Brodie and Richardson also showed another important point, namely, that after the first step has occurred in the shortening, the muscles lose their irritability; in other words, in order to destroy the vitality of muscular tissue, it is not necessary to raise the temperature sufficiently high to coagulate all its proteids, but that when one of the muscular proteids has been coagulated, the living substance as such is destroyed. It therefore appears to be the case that the proteids of muscle are not independent units. The unit is protoplasm, and if one of its essential constituents is destroyed, protoplasm as such ceases to exist.

These experiments in connection with muscle would lead one to suppose that the same is true in regard to other protoplasmic structures; that is to say, the results which have been obtained by the examination of saline extracts of such structures can be applied to the elucidation of the composition of the protoplasm of which they are composed.

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¹ Phil. Trans., vol. 191 B, 127, 1899.

7 Journ. of Physiol., xxiv., 239, 1899.

Our attention has been directed to a consideration of this subject in connection with the question of hyperpyrexia. One of us (F. W. M.) has made observations on the condition of the nerve-cells after death has occurred in this condition. The cells show a disappearance of the Nissl granules; both cell-bodies and processes show a diffuse blue staining with methylene blue.¹

It is a familiar fact that very high body temperature is incompatible with life. Marinesco² has pointed out, in experiments on hyperthermia in animals, that a temperature of 47° C. is immediately fatal; a temperature of 45° C. kills in an hour or two; a temperature of 43° C. kills after a longer Moreover, the occurrence of death is coinlapse of time. cident with the break-down of the nerve-cells in the manner just indicated. It is possible that analogous changes occur in other cells of the body also, but these do not seem to have been specially investigated. The nerve-cells are undoubtedly essential to healthy life, and lend themselves very readily to microscopic investigation, especially by the methylene blue process. A temperature of 47°C. leads to a practically instantaneous disappearance of the chromatophile granules; the same change occurs at 45° C. in a few hours; at 43° C. a longer lapse of time is necessary.

We have been struck with the coincidence of the fatal temperature (47° C.) with that of the coagulation-temperature of neuro-globulin; and we argue that as in muscle, the coagulation of even the lowest coagulating proteid of nervecells would produce a destruction of the life of their protoplasm; a distinct chemico-physical cause can therefore be found for death due to hyperpyrexia.

Still a temperature as high as 47° C. (117° F.) in man is unknown; and we thought it possible that the proteid in question would coagulate at a lower temperature if it was

^{&#}x27;In saying this we do not commit ourselves to the opinion that the Nissl granules are existent as such in the normal cells. The diffuse staining is probably due to a diffusion of the nucleo-proteid material throughout the cell owing to the break-down of the protoplasm.

owing to the break-down of the protoplasm.

2" Recherches sur les Lésions des Centres Nerveux consecutives à l'Hyperthermie Expérimentale et à la Fièvre." Revue Neurologique, 1899. See also Goldscheider and Flatau, "Normale und Pathologische Anatomie der Nervenzellen," Berlin, 1898.

² See "Proteids of Nervous Tissue," by W. D. Halliburton, Journ. of Physiol., xv., 90, 1893.

kept at that temperature a sufficient length of time. We proceeded to put the suggestion to the test of experiment, fully anticipating, in the light of the work of Hewlett and others, alluded to in the opening paragraph of this paper, that the supposition would turn out to be correct. Experiment has shown that this is the case.

The first experiments were made with the brains of cats.¹ After the animal had been killed by bleeding (sufficient chloroform having been given to render it unconscious), the brain was rapidly removed; the grey matter was finely minced and ground up in a mortar with 0.9 per cent. solution of sodium chloride. We selected this solvent as the one likely to produce least change in the constituents of the protoplasm. After repeated filtration the extract remained somewhat opalescent; it was fairly rich in proteid as tested by rapidly boiling a sample. It did not prove at all difficult to see any increase in the opalescence when the extract was carefully heated in a water-bath. The extract was faintly alkaline, but we judged it best not to add any acid to neutralise this, in order that we might deal with as natural conditions as possible.

When the rate of observation is fairly rapid, the first crop of flocculi was observed to separate out at 47° C. These are removable by filtration, and the filtrate is practically clear.

In our next experiment the temperature was not allowed to rise higher than 45°, and was kept between 44° and 45° C., being more frequently nearer the lower than the higher of these limits. In somewhat less than two hours the separation of floculi took place, and as good a coagulum was ultimately obtained at this temperature as was obtained in the first experiment at 47° C. Previous to the formation of actual floculi, there was an increase of opalescence, which became denser as time went on.

In the next experiment an attempt was made to obtain the coagulum at a still lower temperature, namely, 42° C. (108° F.); here again we were rewarded with success; there was at first the gradual deepening of the opalescence,

¹ All experiments involving the use of animals have been carried out by one of us (W. D. H.) at King's College, London.

and in time a distinct separation of minute flocculi, which increased in number and size. The first separation of visible flocculi occurred about three hours after the commencement of the observation, and an hour later the crop was fairly abundant, though the size of the coagulum was not so great as in the previous two experiments. After filtering, the flocculi were, of course, removed, but the filtrate was still distinctly opalescent. Doubtless if we had continued to watch the tube for a longer time the coagulation would have been more complete.

The next experiment consisted in trying a still lower temperature, namely, 40°-41° C. In this case, however, though the tube was watched for eight hours, there was no coagulation.

We have repeated this series of experiments several times, and in some cases instead of grinding up the brain substance with salt solution only, we have employed clean sand or powdered glass as well. By this means one obtains an extract richer in proteid, filtration is easier, and the filtrate clearer. The phenomena of heat coagulation are exactly the same as in the experiments just described, but the proteid being more abundant they are more readily seen.

In a further series of experiments we have employed human grey matter, removed from the cadaver as soon as possible after death. We have selected the optic thalamus as a convenient mass of grey matter for this purpose. The results absolutely agree with those already given.

We had hoped to have had an opportunity of similarly investigating the grey matter after death had supervened in hyperpyrexia; but since we began this work no such case has come under our notice. We have accordingly had to be content with experiments on animals. A cat was, after anæsthetisation, rapidly killed by bleeding; the brain was removed as quickly as possible and divided into two equal halves; this was first done roughly, and then the two halves were accurately made equal by removing fragments of the white matter from the heavier moiety. Each weighed about 9.5 grammes. One half was immediately ground up with powdered glass and normal saline solution, and the extract examined. The other half was first heated to 47° C.

for an hour, and then similarly treated, the same volume of saline solution being used. In the extract of the first (the normal) half, fractional heat coagulation revealed the presence of coagula, which came down at 47°, 56°-60°, and 72° C. respectively.¹ In the extract of the second (the heated) half, the 47° coagulum was absent, but the other two were obtained. The total amount of proteid in the two extracts was also estimated in the usual way, by weighing the precipitate produced by excess of alcohol. 100 cc. of the first (normal) extract contained 0.674 grammes and 100 cc. of the second (heated) extract contained only 0.144 grammes of proteid material. The amount of cell-globulin which passes into solution in normal saline is thus relatively large.

In a second experiment the half-brain was heated to 42° C. instead of 47° C. It was kept at 42° C. for five hours. Examination of the extracts showed that the extract of the normal half gave the usual crop of coagula, and 100 cc. contained 0.483 grammes of proteid; the extract of the half-brain which had been heated to 42° C. gave as before no coagulum at 47° C.; 100 cc. of this extract contained 0.226 grammes of proteid. The chemical examination of brain tissue as fresh as possible thus gave results which exactly correspond to those obtained in the experiments with saline extracts of brain.

The same is true for the histological examination we have made with "surviving" brain tissue.

We have not repeated Marinesco's experiments on hyperthermia in animals, but we have performed the experiment of exposing the brain in situ immediately after death to an elevated temperature. Two cats were anæsthetised and decapitated; the heads were placed in a warm chamber, a thermometer being inserted into the brain through the foramen magnum. In one cat the brain was kept at 44° to 45° C. for one and a half hours; in the second cat, at 42° to 43° for three and a half hours. In each case, and particularly in the first one, the cells exhibit chromatolysis. These experiments completely corroborate the views expressed in the foregoing portions of this paper.

^{&#}x27; See "Proteids of Nervous Tissues," by W. D. Halliburton, previously quoted.

The following are the details of the microscopical examination of the brains of these two cats:—

CAT 1.—Brain in situ was exposed to a temperature of $44^{\circ}-45^{\circ}$ C. for $1\frac{1}{2}$ hours immediately after death. Preparations were made of the cerebrum by the methylene blue process.

Neuroglia.—The cells in the first layer seem somewhat unusually large and prominent.

Small pyramids.—A few cells appear fairly normal, but the majority are swollen both as regards nucleus and cell body; the body of the cell is generally stained deeply; protoplasm is breaking down. Sometimes only a small tag is left by the side of a large pale nucleus.

Medium pyramids.—The body of the cell is generally swollen; the nucleus in some is swollen, in others shrunken and distorted, and the processes of the cells are few and indistinct. Various stages of chromatolysis (perinuclear and peripheral) are seen. No distinct granules are seen in any of the cells, and the reticulum is clearly visible in many of them. All that is left of some cells appears to be a nucleus and some shreds of what looks like stained reticulum. Other cells have a dull, diffuse, granular appearance.

Largest pyramids.—Betz cells. Some cells are much swollen; the processes generally are few and short, and when seen are usually pale. The outline of the nucleus is often not clear; in some cases the nucleolus seems large. No Nissl-bodies are seen in any of the cells, but the protoplasm has a finely granular, somewhat honeycombed appearance, often stained a general dull faint blue. The reticulum is clearly visible in places in some cells. In others there appears to be simply a ring of stained protoplasm, with a nucleus at one side and a clear space in the body of the cell.

Practically none of the cells are normal; all show more or less advanced acute changes. The perivascular spaces are somewhat dilated as a rule.

Leucocytes and small round cells (nuclei of neuroglia?) are fairly numerous, and often in close relation to the nerve-cells.

CAT 2.—Brain in situ was exposed to a temperature of $42^{\circ}-43^{\circ}$ C. for $3\frac{1}{2}$ hours immediately after death. Preparations of the cerebrum were made by the methylene blue process.

Neuroglia.—The cells seem rather large and prominent in the first layer.

Small pyramids.—These are not generally so deeply stained as in Cat 1, and not so swollen; many seem fairly normal, others show breaking up of protoplasm.

Medium pyramids.—These also are not, as a rule, so swollen as in Cat 1. The processes are often fairly numerous and distinct, and Nissl-bodies are seen in many of the cells. Some cells are swollen and show chromatolysis, some stain faintly, others deeply and diffusely.

Largest pyramids.—Some cells are practically normal in shape, and show numerous Nissl-bodies, perhaps rather faintly, in the processes. Other cells are swollen, and stain diffusely. Some are pale, others dark; the body of the cell has a granular appearance. The chromatolysis does not seem so advanced in nearly so many of the cells as in Cat 1; the lymphatic spaces are dilated.

Leucocytes and small round cells are fairly numerous.

Conclusions.

Our experiments confirm our hypothesis, that the physico-chemical cause of death from hyperpyrexia is due to the coagulation of cell-globulin. When this constituent of cell-protoplasm is coagulated the protoplasm as such is destroyed. The temperature at which such coagulation is most easily produced is 47°C. But temperatures as low as 42° C. will have the same effect, provided the heating is continued long enough. These chemical changes in the brain substance are demonstrable by experiments with saline extracts of that tissue, or with the "surviving" brain of animals just killed. They are coincident with the histological (chromatolytic) changes in nerve-cells, which can be rendered evident by the use of the methylene blue method. The expression coagulation-necrosis employed by Marinesco for this appearance is therefore justifiable, though Marinesco and others who have obtained similar results missed the connection of the temperature necessary to produce it, with that of the coagulation-temperature of cell-globulin. Lastly, though the nerve-cells are those which lend themselves most readily to the histological part of the research, it is by no means improbable (looking at the wide distribution of cell-globulin) that many other cells of the body are affected by a high temperature in a corresponding manner.

THE PREVENTION OF DYSENTERY IN THE LONDON COUNTY ASYLUMS.

BY F. W. MOTT, M.D., F.R.S.

THE prevalence of dysentery at Claybury Asylum led to the Committee instituting an investigation of its cause and remedy which was subsequently extended to all the London County Asylums. At my request, a bacteriologist was appointed in the person of Dr. Durham. The investigation was carried on for six months, with the result that a report was issued, and the system of notification of all diarrheal and dysenteric cases was adopted in the London County Asylums, together with as far as possible the adoption of the recommendations which were contained in the report for the prevention of the disease.

The Commissioners in Lunacy have adopted this form of notification, and in their latest blue book make special mention of the fact now established, that dysentery is a communicable disease. It is therefore preventible, and should be prevented.

In this short paper I propose to give some practical suggestions based upon experiences which I will mention of the clinical symptoms in the different types of the disease, the post-mortem appearances of the intestines, the pathological significance of the same—instances of the mode in which epidemics have occurred and the disease been communicated from one case to another, the affection of doctors, attendants, and nurses, and the identity of the symptoms with those of the insane, the reasons why it should not be looked upon as a disease due to mental affection or that it affects patients suffering with any particular form of insanity, or any particular age—or that epidemics are limited to any particular period of the year, or influenced by the usual diet. The experience thus gathered from the returns

made by the London County Asylums, since the system of notification has been adopted, tend to show conclusively that the disease is communicable and preventible. Finally, suggestions will be made as to how the disease may be prevented more effectually.

There are four essentials for the prevention of dysentery:—

- (1) A knowledge of the clinical symptoms of all the different types of the disease—for I have ascertained with absolute certainty that it is more especially the atypical and the recurrent cases of the disease which are not recognised—that occasion (as so frequently in typhoid) epidemics of the disease.
- (2) The systematic post-mortem examination of the bowels in all cases that die. It will then be found that many cases, which are supposed to have died from other causes, were the victims of an acute form of dysentery.
- (3) The recognition of the fact that dysentery should be treated like typhoid in every respect as regards care of the sick, isolation and complete disinfection.
- (4) The notification of all cases of diarrhea and dysentery, and the strict supervision of all suspect cases. The fact that dysentery is recurrent, and the still more important fact that these recurrent cases are infective, necessitates a system by which such patients are marked, and so marked that the attendants who are in charge of them are always alive to the fact that they may become foci of the spread of the disease.

There is no essential difference, as was shown by the discussion at the Epidemiological Society, between the dysentery affecting the sane and the insane and between the dysentery of the Tropics, and that met with in these institutions. The *Indian Medical Gazette*, July, 1901, in a leading article entitled "The Dysentery of English Asylums: a Revelation," thus commented upon this view. "We find that these two distinguished pathologists absolutely agree with the view we put forward of the essential identity of the Asylum disease, and the dysentery which we know only too well in India." 1

¹ Indian Medical Gazette, February, 1899; January, 1900.

Dr. Gemmel, in his valuable work on "Ulcerative Colitis," pointed out that no one with any knowledge of dysentery would hesitate in calling the disease he described The disease is the same which was once so prevalent in England, and was so graphically described by Willis, Morton, and Latham and Baly in the Millbank prison epidemic, but by becoming rarer and rarer, coincidently with improved sanitation in this country, and by occurring in only a mild type, it has to some extent become unrecognis-Probably nothing did so much to retard the prevention of this disease as (a) the introduction of the term "colitis," which, being of a non-committal nature and not connoting defective sanitation in the same way as dysentery, was less disturbing to the conscience of the authorities, although the sudden outbreak and death of a number of patients from "colitis" must have awakened in their minds the fact that it ought not to be; (b) the theory that this infective disease which occurred in asylums was due to a hypothetical nerve lesion, and therefore not preventable. Fortunately, one of the chief supporters of this theory has now recognised its infectivity and preventability in an endemic or epidemic form.

Clinical Phenomena.—Chills or a rigor, accompanied by headache and frequent vomiting, sometimes of a bilious character, associated with high fever, indicate the onset. the patient be an epileptic or a general paralytic, he may have a fit, or series of fits, and die; the patient may then, if a post-mortem examination is not made, be certified as dying from the fits, or pneumonia, which it resembles so much in its onset. Frequently indeed, at the post mortem, associated with the greatly congested red and swollen appearance of the internal lining of the large intestine, and not infrequently also of the lower portion of the small intestine, there is engorgement of the lungs, especially at the bases, and even pneumonia. In some few cases, the blood-poisoning may be so virulent that there has not been time for the characteristic dysenteric stools to have been observed; and only the fact of an epidemic of dysentery at the time would lead the clinician to suspect the true nature of the disease. The fever, in some of the cases, remains high until the fatal termination; in others, collapse and even subnormal temperature soon supervene. Diarrhea may come on shortly after the onset, or only after a day or two, soon followed by blood and slime in the stools. Commonly the disease is of a milder type, and presents the following symptoms:—chills or rigors with pyrexia, followed by frequent evacuations of the bowels, accompanied by pain and tenesmus. Very frequently, however, owing to the mental condition of the patients, pain is not complained of.

Physical examination of the patient may reveal some distension of the abdomen, due to moderate tympanites; rigidity of the abdominal muscles, and tenderness on pressure over the cæcum or colon in its whole tract or in part. The face is drawn, the tongue red or furred, the pulse frequent and small.

"Occasionally the patient is blanched from loss of blood, and recently at Colney Hatch a patient suffering with advanced tabes died from hæmorrhage. This patient, who was in a ward where several severe and fatal cases of dysentery had recently occurred, was suddenly attacked with vomiting and fever; he was put to bed and died in two days. I made the post-mortem examination. The large bowel was filled with blood and there was a considerable quantity of slime. There was no ulceration in any part of the alimentary canal and the only pathological condition which would account for the hæmorrhage was an acute dysenteric inflammation of the whole of the lining of the large bowel and the lower portion of the small."

The stools may contain much blood and slime, which is of a gelatinous, translucent or opaque, whitish or blood-stained or greenish (due to altered blood) appearance. Blood may be only recognisable microscopically; and the slime when similarly examined is very frequently found to consist almost entirely of polymorphonuclear leucocytes, decaying epithelial cells occasionally, and a variable amount of mucin. As a rule, however, this is relatively small in quantity. The stools are generally peculiarly offensive, and I can usually smell out a bad case of dysentery in a ward. The attendants tell me they can diagnose a case by the smell of the stools.

The slime consists almost entirely of polynuclear leucocytes, the cell, par excellence, of the blood and acute inflammation, vide photomicrograph of a specimen, fig. 1, Plate I.. obtained from a case of recurrent dysentery, and it is quite characteristic of all forms. Sometimes in cases of more than a few days' duration specimens of the large mononuclear macrophage cell may be found; also, in sections of the colon in similar cases which come to the post-morten table. these and other large cells may be a striking feature of the As regards other constituents in the acute inflamed tissue. cases, passing only blood and slime, one notes a remarkable scarcity of bacteria present. Osler also notes this; when fæcal matter is present, of course, bacteria of many sorts teem in the preparation. If dysentery is caused by any of the "bacilli coli," which have been described by many different authors, their share in the pathology of the disease is very different from that played by the "cholera vibrio" in cholera; for in that case enormous numbers of the vibrios are present, often, indeed, almost in pure culture.

Dr. Durham, who investigated this matter, found that such bacteria as are to be seen in such clear dysenteric stools are of various sorts, ordinary cocci and bacilli of various sizes, some of which retain the stain after iodine treatment, and some of which do not. Besides the above, he observed minute micrococci, which he had reason to believe had a possible causal relationship to dysentery.

A negative observation as regards blood and slime by the naked eye does not contravene the possibility of a given case being dysenteric; a case of dysentery does not always, and may never, pass one of the so-called stools.

It is very necessary to consider, as in typhoid, the atypical cases as being forms of one and the same disease; and our experience would show that there are at least seven clinical types. The practical importance of this is shown by the fact that a mild atypical case can be the starting-point of an epidemic in a particular ward. The disease having once started, its virulence seems to increase; even

[&]quot;"Report on Colitis, or Asylum Dysentery," by Drs. Mott and Durham. King and Co.

young and physically healthy patients, as well as the old and infirm, are then stricken down; and cases occur of a very severe type, similar to those which affected the prisoners at Millbank, and resembling in onset and clinical symptoms a very severe acute specific fever.

CLINICAL TYPES OF DYSENTERY IN ASYLUMS.

- (1) The acute case with preliminary fever, lasting till death supervenes in about two to ten days. Chart I.
- (2) The acute case with preliminary fever, and a temperature which falls rapidly as the collapse proceeds.
- (3) The case with mild fever, 101° to 103°, and diarrhoea, for a day or two, accompanied by diarrhoea with blood and slime in the stools for a few days to a week or more; terminating, however, in recovery. Chart II.
- (4) The mild case without fever, but with diarrhoea, accompanied with blood and slime, lasting over two days. In some of these cases there may have been initial fever, which was overlooked. Chart III.
- (5) Cases of varying degree of severity in which, after an interval of a few days, symptoms recur, sometimes with fatal results and sometimes with recovery. Chart IV.
- (6) Cases which do not clear up after the first week or two, but which become chronic: the patients continuing, at more or less intermittent intervals, to pass bloody, slimy, diarrheal evacuations for months. Such are common.
- (7) Cases of intermittent or prolonged diarrhœa in which neither blood nor slime has been noticed in the stools, and yet *post-mortem* dysenteric lesions of a similar nature have been found.

Some of these are no doubt old cases, which have suffered at some previous period with dysentery. I have now large numbers of records of patients who have had three or four attacks, and at the last succumb. In fact, the majority of the cases which now occur in the returns at Claybury are patients who have had previous attacks of the disease.

(8) Cases of dysentery associated with pulmonary tuberculosis. Tuberculosis of the lungs frequently, and of the

CHART I.

Name C. B.; age 45. Ward, M. I., August 28, 1899. Isolation Hospital, August 31, 1899.

AUGU	TE 1899	28	29	30	3/	Sop	2	3	4	5	6
	DAY OF DISEASE	1	2	3	4	5	6	7	8	9	0
	106° 4	000									
135	105° 2	Spar	ged								
	104° 2	1	Spa								
	103° ½		8	*******							3.17
	102° 4		/\:					***************************************		9	220
	101° 4							1			Died
	100° ½		1			/					*****
	99° 2				/\		\				
	98° 4						1				
	97° 4										
	96 4										
Pulse		/	/	juli	98 96	98	102	98 104	96		/
Respire	ation	/	1		19/18	18 20	20/19	18	22	32	/
Bowe/s		23	0/2	13	83	4 2	3,	43	3 2	10	
Slime in	1 X	THE RESERVE AND ADDRESS.	00	06	XXX	XXX	XX	XXX	XX	XX	
Blood in	. X	00	00	00	XXX	XX	XXX	XXX	X	O	
UrinelA	LIX							Whis 3v	key daily		
Treatme	ant		Č.				M	M	M	M	
Diet		Milk & Bee	F Tea	->	Mill	& A	rron	roo	-		

Example of a case of severe dysentery, which terminated fatally on the ninth day, in a chronic male epileptic, admitted to Claybury Asylum March 26th, 1895. Seized with slight diarrhea and high fever on August 28, 1899. Three days later, when the temperature had fallen nearly to normal, blood and mucus occurred in the stools, and the patient died six days later—the disease being complicated two days before death by broncho-pneumonia. Patient was treated with mist bism. and opio, and milk and arrowroot diet. At the autopsy, the whole of the mucous membrane of the large bowel was found swollen, red and inflamed; there were a few small ulcers in the descending colon, sigmoid flexure and rectum. The spleen was swollen, soft, and congested. The lung showed hypostatic congestion of the bases, and there were petechiæ on the serous covering of the right lung.

CHART II.

Name, Attendant M. O. E.; Age, 26. Ward, Isolation Hospital, August 24, 1899.

DATE AUG	DAY OF DISEASE	106° 4	105° %	104	103° 2	102° 3	101° 4	100°	99° 4	98° 4	97° 4	96.	Pulse	Respiration	Bowels opened	Slime in stool XXX	Blood in stool XXX	Uring (Albuman)	Treatment
24	me 8		9 006			•							76	8/.	18	XXX	XXX	O	Σ
25	Sam.								1				78	18/	18		XXX		Σ
26	12.58 W									`			78	8/	13		XXX		Σ
27	m.68									7			88	1/8	00	· ×	XXX X		Σ
28	m.68												78.	18	4 4	XXX	××		Σ
23	mq 8							•					78 0	8/ 0	0,0	XX	o ×		Z
30	ma 8									9			80 2	91 8	N	0	0	0.618	
3/	m k 8									4	{		87 70		2	× 0	×	0	Σ
-	.m.68										P		IN.	10	0	×	00		0
4	MA 8					2	Q. E	<i>J</i> (/		•)		72 88	. 0	3	×	00		0
3	ms 8					w	ø c	do					18	18	2	x x	00	-	0
4	ma8 N.S.									•	•		27	7 /8	2 3	×	0		0
3	m48 m68									6			. 00	. 0	N	×	0		_
	m48 m58									#	•		# 22		0	× 0	00		0
9	M48 M.58										6	11.	.0	N	0	0	0		0
7	mq 8									•	$\langle \cdot \rangle$		72. 7	18/	20	O	00		0
80	MAB MAB											2.1.	99	11	0	, o	0		0
0	WE 8									•			02	18	0	10	0		0
10	m68 00 m98										3		72	18/	0	0	0		0
>	m 6 8									٩	•		72	17	00	0	00	e pa	300
2	m.68 m.q.8										S		72	18	2 2	00	0		0
15	M.58				Ш					•			20	1	1	1	1		0

References to Diagrams:—

x x x, very much; x x, much; x x, much; x, some; M, Medicine; I, Injection—under heading "Treatment." Change of medicine should be indicated by M²,

Example of a severe case of dysentery in an attendant. He was at work during the day in Ward No. 1, Claybury Asylum, and slept in a bedroom off Ward No. 2. It is probable that the patient acquired the complaint in Ward No. 1, where four cases had occurred during the preceding twenty days. The attack began with high fever, lasting only one day, and not again exceeding 100 degs. Bowels were moved from fifteen to twenty times a day at first, afterwards less frequently. Much blood and slime were passed during the first eight to ten days, and the sime continued for nearly three weeks, when the patient was pronounced recovered. He is now in good health, and tells me that there are no after effects of the disease. He was a young, strong man, and no doubt had a high resisting power.

CHART III.

Name, E. A.; age, 43. Ward, Hospital.

January	T E 1900	8.14	974	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	DAY OF DISEASE	1	2	3	4	5	6	7	8	9	0	ī	2	3	4	5	6
	106° 4																
	105° 5																
	104° 2		E. 13 (***********************************						4	(**** 							
	103° 2						8		Y								
	102° 2					i	Chie										
	101° 2	CONTRACTOR	MF. to apost	** *** *** **** ** *** *** *** * ** * *** ***			711 140					7					
	100° 2			**************************************			MoN										
	99° 2				Å												
	98° ±	L. 5		A	þ	6		٨							1		
	97° ‡		ď	V				V		\wedge	- J	1	13		1	1	
	96° 2								V		V	V				3	
Pulse		/	/12	74 80	76 68	80	80 82	78 76	80	64 68	70	70 52	60.	64	56	60	60
Respira	non	/	10	22/20	24/18	20/24	20 18	20/18	22/24	24	18	20	16	18	18 24	20/18	16.
Bowels o	pened	/	"0	30	02	20	10	00.	00	00	00	00	00	00	00	00	1
Slime in s	rool XXX	×	XXX	XX	XX 00	XXX	00	00	× 0	00	00	00	00	00	00	00	
Blood in	stool ×××	1/8	X XX	XX	XX	XX	*0	00	00	00	00	00	00	00	00	00	
Urine (A)	AMA										-						
Treatme	nt	1&M	I&M	1&M	IBM	I&M	IAM	1&M	18M	1&M	IBM	M	M	M	M	MI	M
Diet	51.50		M	M	M	M	M	M	M	M	M	MI	MI	MI	MI	MI	M

Example of a moderately severe case of dysentery, with practically no pyrexia, occurring in a woman, the subject of chronic recurrent melancholia. The only diagnostic symptoms of the illness were much blood and slime in the stools. She was admitted to Claybury Asylum September 19, 1899, and the dysentery commenced January 8th, 1900. She was treated with mist. bism. and quinine injections. Diet—milk and arrowroot. Recovered on January 23.

CHART IV.

Name, J. G.; Age, 38. Ward, Isolation Hospital.

DA	TE 1899	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9
	DAY OF DISEASE	1	1.8m.	8. p.m.	4	5	6	7	8	9	0	1	2	3	4	5
	106° 4		20000													
	105° 2		\$ 20.30 0.000													
	104° 2															
	103° 2			*** **********************************												
	102° 4			\	1	*										
	101° 4			1		j	1				do					
	100° ½				•		1	28					; <u>.</u>			
	99° 4			-		1		3								
-	98° 4				1				V							
	97° 4				8							V		•	~	6
	96° ½															
Pulse		1	5.p.m. 108 4	90	96 86	90	110	98	96 94	98 :	76 68	70 68	70 68	70	68	70
Respira	ition.	/	5 p.m. 24 22	16 18	20/18	18/20	22/19	18	18	20/19	17/18	18	18	17/18	16	16
Bowels		1/2	4 x6x	4/3	3 4	2 3	3/1	2/	2/2	2/2	1/	2/	1/1	2	24	00
Slime in	l X		XXX	XXX	XXX	XXX	XX	XX	XX	XXX	XX	XX	×	XX	× o	00
Blood in	l X		XXX	XXX	XXX	XXX	XX	00	00	00	00	XX	X o	XX	× o	00
Urine(A	Ibumen) X X X X X X X X X X X X X X X X X X X															:
Treatme	ent	M	М	M	M	М	M	М	0	0	0	0	Q	0	0	0
Diet			Mil	4 8	Ar	row	1001	-			-	Ord	inar	V-		

Example of a moderately severe case of dysentery, occurring in a chronic epileptic employed in the upholsterer's shop, Claybury Asylum, in picking hair of old mattresses requiring to be re-made. Typical sudden onset with shivers, vomiting and high fever, with blood and slime in the stools; treated with mist. bism. c. opio, milk and arrowroot diet; terminating in recovery.

CHART V.

Name, C. B.; Age, 38. Ward, 2 I.

DA	TE Oct.	23	24	25	26	27	28	29	30	31	1	2	3	4
W	DAY OF DISEASE	1	2	3	4	5	6	7	8	9	0	1	2	3
	106° 2			4 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -								7		
	105° 2									4				
3) 1	104° 2					**************************************								
IS INC.	103° ½									X				
aun I	102° 4	9			8		8					7		
AL DO	101° ½													
	100° ½		/\			\bigvee	\/			Å				12
enio	99° 2	2		\bigvee			•	1	V	$\sqrt{}$	\/		-	Deal
	98° 4	1	1		3			V						8
and the last	97° 4													
amb i	96° 2												V	
Pulse		90	/	/		100	/	/	37	./	100	7	92	7
Respira	tion	/	/	/			Y	/			/	/	1	7
Bowe/s	opened	2:2.	2	2.2.	-2	1.3	3.3	41	2.2.	3.2.	2.3.	4.3.	2.3.	3.
Slime in	I X		-	-	-	-	-	-	-	-	-	-	-	-
Blood in	srool ×××	-	-	_	-	_	-	-	-	_	_		_	Щ
Urinela	Ibumen) XXX									PET				
Treatme	ant	M.												1
Diet		Mi	lk.	Br	and	1 .		,						

Example of a case of dysentery associated with pulmonary phthisis, altering the character of the temperature chart. Patient was admitted to Hanwell Asylum, suffering from acute mania, August 18th, 1899, and was attacked with dysentery October 23rd. The chief symptoms were continual diarrhea, some mucus at the onset, none afterwards; no blood. Patient was treated with salol, bismuth, and opium mixture; but the case terminated fatally on the thirteenth day. Post-mortem examination showed the ascending colon studded with small ulcers, which were discreet with no surrounding inflammation; likewise the transverse colon and descending colon. The sigmoid flexure, the rectum, and the cæcum to a less extent were honeycombed with ulceration; the whole of the mucous membrane was being destroyed, the sub-mucous tissues greatly thickened and of a deep claret colour; the small intestine was free from ulceration. The mesenteric glands were, however, tubercular. Spleen small, pale and shrivelled. The upper lobes of both lungs riddled with cavities. It was extraordinary with such a large amount of ulceration in the intestines that there was no blood in the stools. The absence of ulceration in the small intestine shows that the diarrhea was not due to tubercular disease of the bowel.

intestines occasionally, may be associated with dysentery, and it is very difficult clinically to differentiate these cases. The temperature chart, however, is usually significant. Not infrequently these cases are at first returned as cases of dysentery, and subsequently, when the pulmonary physical signs are unmistakable, as tubercular ulceration of the bowel. Post-mortem examination shows frequently, as in Case C. B., Chart V., the small intestine free from ulceration, but the large affected by the characteristic dysenteric lesions. Such are cases of dysentery affecting patients suffering with pulmonary tuberculosis, and it would be surprising if such cases did not occur, seeing that tuberculosis is very prevalent in asylums. In a measure many of the causes which induce dysenteric affection operate in the acquirement of tuberculosis by the inmates. Some of these cases indicated secondary infection of the dysenteric lesions by tubercle bacilli, for I have found them in typical dysenteric ulcers of the large intestine. This is to be expected, seeing that insane patients suffering with pulmonary tuberculosis seldom expectorate.

MORBID ANATOMY AND PATHOLOGY.

I shall now pass on to a description of the post-mortem appearance of the intestines, and I may say that, with the exception of a few very acute cases, I have never seen two alike. If the patient succumbs in a very few days after the onset, one finds the walls of the whole large intestine, and frequently the lower part of the small intestine, greatly thickened; the internal lining is swollen and red; often small red hæmorrhagic points or elevations are seen scattered over its surface; the solitary glands, however, are not perceptibly swollen; owing to the marked thickening and swelling of the submucous coats, the mucous lining cannot be moved with the finger over the subjacent tissue (vide photomicrographs 2 and 3, Plate I.).

Microscopical examination reveals acute inflammation of the submucous coat, especially with engorged vessels and profuse infiltration, which extends into the mucous membrane; [and already necrotic changes can be seen to have affected the epithelium, the cells of which are swollen, opaque, bursting, or disintegrated.

Acute fatal cases of a little longer duration show the same swelling; but now frequently the mucous lining, although swollen, presents a pale gray or dirty whitish-gray appearance; the surface is sometimes finely or coarsely This is owing to stasis in the vessels of the submucosa and necrosis of the epithelium, and the formation of a false membrane, consisting for the most part of leucocytes and disintegrating epithelial cells (vide Plate II., figs. 4, 5, The commonest form of the disease met with on the post-mortem table is where some portion or the whole of the large intestine is the seat of ulcers of various sizes, from a pin-point upwards. The wall of the intestine may be thick in one place, thin in another; the seat of necrosis of epithelium in one portion, of ulceration in another; while in other places a healing process has left polypoid elevations or patches of thickened mucous lining. These have rounded edges which are adjacent to portions of the bowel denuded of mucous membrane; often the submucous coat is destroyed entirely, exposing the muscle, and even this latter may be occasionally partly or completely destroyed. I have seen a few instances of perforation arise from ulceration of all the coats, death occurring from septic peritonitis.

The ulcers are circular (vide fig. 7, Plate III.) or irregularly coalescent; the lumen of the bowel may be greatly increased (vide fig. 8, Plate III.), or it may be contracted, as in another case, in which the patient succumbed to an acute attack following three previous attacks, spread over some years. In some cases, in which death occurred from other causes after the dysenteric symptoms had declined, one found pale, somewhat smooth patches, rather more opaque than the surrounding mucous membrane, often more or less invaded by irregular patches of a pinkish or dull purplish hue; these were probably the scars of previous ulceration. Microscopically, they do not show much beyond the wasting of the mucous follicles and increase of interstitial cells. The solitary follicles are frequently seen in these cases surrounded by pigment or a zone of redness (vide fig. 9, Plate III.).

Post-mortem appearances of the gut may then be most varied; and I see no difference between the appearances presented on the post-mortem table of this dysentery in asylums to the dysentery occurring elsewhere. It must, however, be clearly understood that, as in the sane so in the insane, inflammatory lesions of the colon or other parts of the intestine, non-dysenteric and non-infective in nature, may occur, and that I do not deny the existence of inflammatory lesions of the large bowel, occasioned by Bright's disease, syphilis, &c.; nor do I contest the possibility of stercorous ulcers; but what I do affirm is that these are relatively infrequent and unimportant compared to dysentery.

Seeing that there is a great difficulty in the insane of separating clinically such cases from the atypical recurrent or mild dysenteric cases, it is essential that all cases of diarrhœa lasting more than a few days (especially in asylums where dysentery is endemic or has been epidemic), should be regarded as suspect. Again, it is not safe to assume that a patient who has well-marked pulmonary tuberculosis may not also be suffering with dysentery. When blood appears in the stools, or even diarrhœa occurs, it may be due to a dysenteric lesion. I have shown the temperature chart of such a case. Occasionally at Claybury, in recent times, we have had simple cases of tubercular disease isolated for dysentery. Not infrequently one finds old dysenteric lesions of the large bowel with recent tubercular ulceration of the small intestine.

NERVE DEGENERATION AND DYSENTERY.

The hypothesis that dysentery (ulcerative colitis) is due to nerve degeneration associated with insanity was maintained for many years by Dr. Claye Shaw, but Dr. Goodall in the discussion upon this subject at the Epidemiological Society, made the following remarks: "Since coming to this meeting, I have read Dr. Claye Shaw's observations upon Dr. Mott's paper; and from them I gather that he has practically abandoned the view he formerly held as to the nature of this disease. He admits it to be bacterial and almost certainly infectious. To him the behaviour of the disease

is still 'something of a mystery.' But as I read the sentences immediately preceding this confession, I am at once vividly reminded of another disease concerning the infectious nature of which there can be (now) no question, I mean diphtheria."

Dr. Shaw's position as far as I can gather now is, that sporadic cases may arise de novo and be the source of infection.

EPIDEMIOLOGICAL FACTS INDICATING THE COMMUNICA-BILITY AND MODE OF SPREAD OF THE DISEASE.

The consideration of the occurrence of dysentery in particular wards of asylums leads to the conclusion that it is communicated by infected patients to those previously free in some direct or indirect manner. The possible modes of communication were due in part to the ignorance of the attendants, who had not appreciated the communicability of this disease, or exercised sufficient care in preventing its spread by attending to their own personal cleanliness, or the personal cleanliness of the patients, in the matter of washing hands after assisting in menial ward duties; which include cleaning up patients, taking away foul linen, and the handling of utensils and food in the preparation for meals.

In our report we cited numerous instances of the possible modes of communication; however, some fresh and very striking instances have come under my notice, and it will be to these that I shall now refer.

(1) I have already referred to the prevalence of the disease at the New Bexley Asylum, and I have no doubt that it was introduced there by transfers from other asylums. Dr. Stansfield, the superintendent who took part in the discussion at the Epidemiological Society, was of that opinion. Still there can be no question that it spread and assumed an epidemic form in certain wards. The following facts are collated from the weekly reports of this asylum:—

The cases of diarrhoea for the twelve months, September 1, 1901, to August 31, 1902, have in comparison with the other asylums been exceedingly high. Twenty-four cases of

dysentery have been reported, and 142 cases of diarrhoea on the male side, with four members of the staff suffering with diarrhoea. The great bulk of these cases occurred during September, October and November, and they nearly all came from K1 Ward.

During the twelve months, eleven out of the twenty-four cases of dysentery, or 45 8 per cent., have been reported as coming from this ward, and fifty-six cases of diarrhœa (nineteen of which were severe, out of total 142 (39 47 per cent.).

The outbreak of diarrhoea in K1 was attributed in the report furnished to probable carelessness in the cleansing and disinfection of the soiled linen from that ward.

On December 17, 1900, the East Villa was converted into an isolation hospital for diarrhœal diseases and phthisis, and it is noted that K1 is being thoroughly cleansed and disinfected. For the next five weeks the cases abated somewhat; however, K1 still contributed the great majority.

February 15, diarrhea cases have been removed from East Villa back to K1, the former being required for the isolation of small-pox cases. Following this change we have immediately seven cases of severe diarrhea reported from this ward. I have already alluded to the fact that post-mortem results showed that some of these cases which were returned as severe diarrhea, were in reality dysentery.

(2) At Cane Hill Asylum, which has been singularly free from dysentery, a slight outbreak on the male side occurred in the Spring of 1902. Isolation was practised early, and the epidemic was nipped in the bud. I made a post mortem on one of these patients two months after complete convalescence. If the clinical notes had not informed me that he had suffered with a severe attack of dysentery, one might easily have overlooked in the examination of the bowel the scarring of old ulceration, so complete had been the healing process. He was a tabo-paralytic who died in epileptiform seizures. The complete healing of the bowel in spite of the severe attack, and a very marked posterior

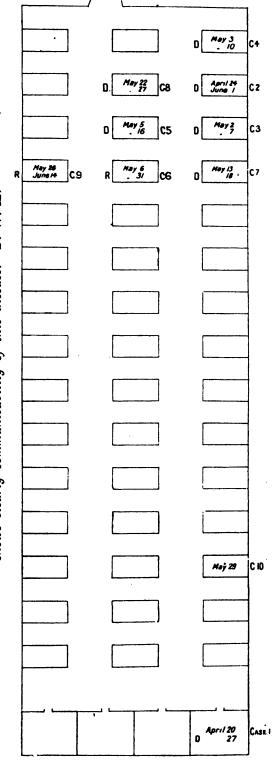
root and tabic degeneration of the spinal cord does not support Dr. Shaw's theory. For if his views were correct, nervous degeneration being the cause of the disease, this is the case, par excellence, which should not have healed.

- (3) The accompanying diagram which was published in our report illustrates an outbreak in a new temporary ward at Colney Hatch. It is so very striking that I reproduce it again. Ten patients were affected with dysentery; eight of them occupied adjacent beds, and were successively affected; seven of them died. The first case occurred in a side room on April 20, the second case occurred (probably the infection was conveyed by the attendant) on April 24, when fresh cases occurred occupying adjacent beds.
- (4) An outbreak which I investigated at a private asylum began in an atypical case, spread to patients in three adjacent single rooms; the night nurse became affected, as also a number of cases whom she attended at night. The nurse died, and a post mortem was made, with the result that an acute dysenteric inflammatory affection of the large intestine and lower part of the small intestine was found. The fact that only the inmates of the asylum who were under the care of this nurse were affected, appeared to me to exclude the food, milk, and water supply.

OUTBREAK OF DYSENTERY IN WARD 20, MALE SIDE, HANWELL.

(5) All cases of dysentery and diarrhea had been notified since March 2, and not a single case had been returned from this ward. In August, 1901, twelve cases of dysentery and several of diarrhea were reported from this ward. The case first notified was in a night attendant. On the night of Saturday, July 20, the night attendant Harris, a man who had been thirteen years in the service, suffered with slight colic and nausea, but no diarrhea. He went home, and the pains became much worse. At noon on Sunday he passed the first loose motion, at one p.m., after which diarrhea became severe, and the third motion contained a little blood. He continued to pass blood and slime throughout Sunday

Plan of X 1 Temporary Buildings, Colney Hatch, in which an Outbreak of Dysentery occurred in April, 1900, which shows clearly communicability of this disease.—F. W. M.



The date of onset and duration of the disease in each case is indicated in the space representing the position of the bed; those with D indicate that there was a fatal termination; those with R indicate recovery. The order of sequence of onset is indicated by C and a numeral and Monday. He returned to duty on July 30. Several cases of dysentery now occurred in this ward, and on August 21 a young attendant who had been in the service only six months was attacked with the disease. It began with vomiting, headache, loss of appetite, and fever. According to his own statement, he was well acquainted with dysentery, having served as an orderly in India and nursed many cases. On the second day after the onset of the symptoms he commenced to pass blood and slime in his stools, which continued for ten days longer. The fever continued for a week, and he was very thirsty. For two or three days after the onset he suffered with attacks of vomiting, and for more than a fortnight with severe gripes, tenesmus, and pains in the belly. He was off duty about one month. He never had the disease in India, but he considers that this form of the disease is quite as severe in its symptoms as that which he saw in the hospital in India.

In answer to a question he stated that he had never been told that the disease was infective, but he now knew it was. When changing a patient he always took care to wash his hands, but admitted that on many occasions he had to rush off from changing a patient to attend to other ward duties without having had time to cleanse his hands.

He thought the handling of eating utensils and of food, under such conditions, might easily be the means of communicating the disease. Since the outbreak, feeding-cups, knives and forks of each patient were kept separate. The ward is well ventilated; and, except the first thing in the morning, there was no offensive odour, except when there are dysentery cases, and then the smell is very foul and characteristic: stronger here than the smell he experienced in India.

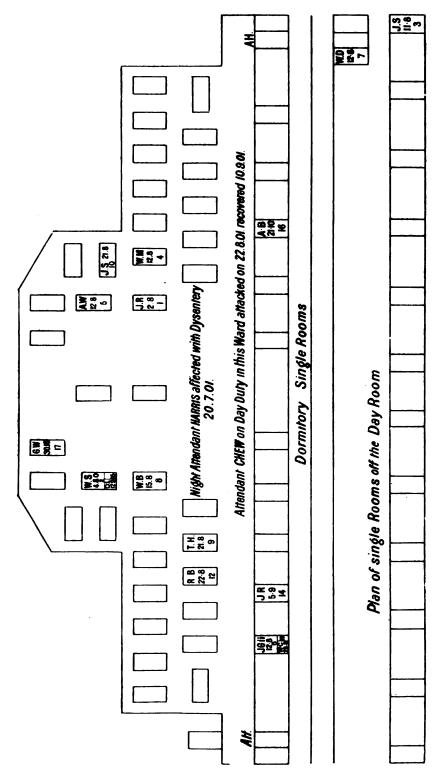
The most probable origin of the epidemic in this ward was the existence of several cases of mild atypical dysentery, which had not been notified, but which there is reason to believe, from a statement of Charge Attendant Farrance, existed. The existence of such cases in the ward was probably the cause of infection of the night attendant, who may, as well as getting it himself, have been the means of convey-

ing it from one patient to another. The statement of Attendant Chew shows the absolute necessity of isolating in a separate building cases of dysentery; or, if that be impossible, of employing an attendant skilled in nursing communicable diseases, who should have no other duties than looking after these patients.

Fifteen patients suffered with dysentery and four with diarrhea in this ward; 35.5 per cent. of the inmates of this ward, and 57.5 per cent. of the dysentery cases of the whole The total percentage of dysentery for of the male patients. the whole of the inhabitants of the asylum was 1.4 per cent. The dysentery cases in this ward made up 40.5 per cent. of the total dysentery cases of the whole asylum (vide plan of ward, p. 755). It thus shows that much asylum dysentery is due to communication of the disease from one patient to another, probably by ignorance, carelessness, or deficient precaution on the part of attendants. For if attendants can acquire they can confer the disease; and it emphatically shows the necessity of isolation of infective cases, and nursing by attendants who have been properly instructed in the nursing of typhoid cases. same precautions require to be taken for dysentery as typhoid. We found that typhoid, which has been recognised by asylum authorities as liable to be conveyed from one patient to another, still, with the precautions that are taken at present, frequently spreads. It is seldom that a case of typhoid remains solitary; usually a crop of cases occur. This was the case at Colney Hatch, where dysentery is also prevalent.

THE DISEASE IS NOT LIMITED TO THE INSANE AND AFFECTS PATIENTS OF ANY AGE AND ANY FORM OF INSANITY.

It is necessary to re-affirm and emphasise these facts, for it has been asserted by Dr. Claye Shaw that attendants and nurses are never affected. The symptoms presented by these sane people in no way differ from those of the patients under their care: except, as a rule, they are not so severe, and they are very rarely followed by the chronic form of



Plan of Ward 20, Hanwell, indicating the beds of the patients affected, the dates of onset, and the number in order of sequence of affection.

Two beds are shown to have had two patients successively affected, this explains two initials and two dates.

756

the disease or by fatal results; but it must be remembered that they are capable of being better nursed, are better nursed, and have a greater vital reaction (vide Chart II.).

Although the disease is for the most part confined to the patients, a number of cases have occurred amongst the attendants, nurses, workers living outside; and occasionally even the higher officials, including medical officers, have been subjects of severe attacks. Information obtained from two practitioners at Woodford, showed that married attendants and workmen at Claybury occasionally came to them suffering with dysentery and severe diarrhoea when the disease was occurring there in an epidemic form.

Dr. George Turner, in his report on the outbreak of diarrhea and dysentery in the Melton Asylum, 1894, speaks of fifty-nine cases among females, of which five were among the nurses; twenty-eight male cases, of which one was an attendant.

Dr. Bailey (Senior Assistant Medical Officer, Hanwell), who himself suffered with a severe attack of the disease, and who, at the Epidemiological Society, gave an excellent account of his symptoms and the mode of treatment he found most beneficial in his own case as well as those of the patients under his care, has kindly furnished me with the following statistics relating to the affection of members of the staff at Hanwell.

	IVI A	ALES.		
				Duration.
Dr. Bail	ey, August, 1900			14 days.
Talbot (S	Store-room Porter), March, 19	01		3 weeks.
Attenda	nt Austin, July 18th, 1901			9 days.
,,	Muds, July 16th, 1901			3 weeks.
,,	Chew, August 22nd, 1901			3 weeks.
,,	Burge, October 31st, 1901			5 days.
,,	Harris, July, 1901		• •	9 days.

FEMALES.

Miss King, Matron, Summer and Autumn,	1899.	3 months (pensioned).
Nurse Tibbot, April 6th, 1901		1 week.
Laundrymaid Spray, April 22nd, 1901		2 weeks.
Head Attendant Brown, September 23rd, 1901	• •	3 weeks.
" Nurse Weston, October 21st, 1901		5 days.

Two Cases of Dysentery occurring in two Laundrymaids occupying a Two-bedded Room. Example of a Recurrent Case leading to Infection of a Healthy Sane Person.

Case 1.

- S. L. M., Ward 20, sleeps in a two-bedded room with D. L. M., over the laundry.
- S. L. M. began to suffer with diarrhea and abdominal pains on April 16, 1901. She remained "on duty" for a week, although the diarrhea did not stop. On April 23 she became so ill that she applied for medical treatment. She was then found to be suffering from severe diarrhea, with both blood and slime in her motions. She was at once isolated in the "hospital" with several other patients who were suffering from a similar condition. After being in the "hospital" for a fortnight she returned "on duty," cured.

Temperature chart during treatment in "hospital" is enclosed.

- D. L. M., who slept in the same room, did not develop symptoms of colitis.
- S. L. M. remained free from "colitis" till December 11, 1901, when diarrhæa and abdominal pain again occurred. There was blood and slime in the motions on December 13. On December 14 she first came under medical observation, and was found to have "recurrent colitis."

During the whole time of her second illness, S. L. M. has been sleeping in the same two-bedded room with D. L. M., in which S. L. M. developed her first attack.

S. L. M., is still under treatment for diarrhœa, with blood and slime in motions, and abdominal pain. Temperature has not been over 99.2° F. at night.

Case 2.

D. L. M., Ward 20, sleeps in the same two-bedded room with S. L. M.

On December 14, 1901, when S. L. M. was found to have "colitis," D. L. M. was ordered not to sleep in the same room

On the night of the 14th, she slept "at home," and on he 15th, in a three-bedded room, with two nurses, in the temporary buildings. On the morning of the 15th she became ill with

L.M. = Laundry Maid.

vomiting, abdominal pain and diarrhea. While "at home" she noticed some blood in the motions.

She first came under medical observation on December 16, and has been isolated with S. L. M. in the Nurses' Block.

A. E. BAKER.

Hanwell, December 16, 1901.

The evidence, therefore, clearly shows that the sane as well as the insane are liable to this disease, but it affects the latter more frequently and more severely because, firstly, there are more chances of the disease being communicated, and, secondly, because the general health is so frequently enfeebled, and there is greater difficulty in nursing the insane. Exactly the same applies to typhoid epidemics in asylums; the disease is much more liable to spread, and the mortality is very much higher, than in hospitals.

THE PREVENTION OF DYSENTERY IN ASYLUMS.

In many respects, the sanitary condition and hygiene of asylums where dysentery was prevalent were not good: e.g., at Claybury, the drains were all defective wherever tested, and leaked into the subways that served to supply, in the winter time, the warm air to the building. During the prevalence of the disease at Claybury, we found lettucebeds irrigated with raw untreated sewage. At other asylums we found imperfect destruction or sterilisation of articles known to be contaminated. In one asylum, foul mackintosh sheets were being washed in a bath; patients washed their hands at slop sinks; and, during our presence in the ward, the excrement of a known case of dysentery was disposed of down the same sink; within a few yards was the proper, but locked, ward lavatory. The care in personal cleanliness on the part of the attendants and nurses in the wards where dysentery was prevalent required supervision and improvement; the washing of hands of patients in the lavatory, at any rate, only took place in the morning, when they got up, the lavatory door being locked, towels and soap being all ready for the next morning. I was glad to find, on a visit to some of the wards at Claybury, a short time ago,

the patients using the lavatory to wash their hands before having their meals; and to this attention to personal cleanliness, as well as to the greater care exercised by the attendants in the recognition of the disease, the knowledge of its communicability, and immediate reporting of the case to the medical officers, together with the diligence with which the medical officers themselves have endeavoured to practise early isolation, I attribute in great measure the steady and marked decline in the number of cases which have occurred at Claybury since our recommendations have been adopted.

The segregation and disinfection of things which come into contact with patients afflicted with any form of diarrhea required more stringency and method, e.g., the nonuse of disinfectors, but especially the cleaning of mattresses, and the removal of foul linen. Mattresses at Colney Hatch and Hanwell were most imperfectly dealt with; in fact, we found experimentally that the hair of the mattresses which were supposed to have been cleaned, contained a larger number of bacteria than before. Another point was the absence of any distinguishing mark, so that contaminated mattresses from one ward "thus cleaned" could be returned to another ward, and, if infective, start disease there. This laxity in sanitary practices suggested defective supervision in these vast establishments. The desirability of keeping systematic notifications of all diarrhea cases and systematic records of suspicious cases is obvious from the fact that it is not improbable that the continued presence of dysentery in asylums may be in great part due to the lighting-up of old cases, and the neglect of precautions in mild and transient It is only fair, however, to point out the great difficulties attendant on the discovery of all these cases among the insane, who are generally mentally incapable of telling you the complaint, and are naturally dirty in their habits. That the dirty habits of the insane in the use of the water-closets and night commodes may readily lead to the communication of the disease by fæcal contamination of the hands of other patients who use the same closet or utensils as dysenteric patients, again, is an argument for isolation. Moreover, attendants should be warned always. to sterilise enema tubes and nozzles, which may otherwise be a source of infection.

Isolation Hospitals.—Although buildings are provided for isolation they are not always available for use, as they are often filled up with ordinary chronic lunatics; the patients may have to be removed to make room for cases suffering with other infectious diseases. This was the case at Claybury, Hanwell, and Colney Hatch. The new asylum at Bexley does not apparently possess an isolation hospital, but a villa has been used in place thereof. At present at Claybury the isolation hospital is filled with female patients who have suffered with a previous attack, or are at present suffering with dysentery; the male patients being isolated in a small separate building. The question of housing the large number of lunatics in the County of London has been a most pressing problem, and the Council have had to consider the ratepayer as well as the pauper lunatic; that there has been great overcrowding no one will deny.

WARD AND ASYLUM TRANSFERS.

I do not consider overcrowding in itself such an important cause of spreading the disease as the various shifts that have to be resorted to to make accommodation for patients, such as the filling up of isolation hospitals, and the transference of cases which have suffered with dysentery from one ward to another. Thus, in the Report of the Pathological Laboratory, May 21, 1901, I pointed out that one of the female patients who had died of chronic dysentery was in twenty-three different wards in five and a half years, including four periods in the isolation hospital, during the last of which she died. Another was in sixteen wards in seven years, including two periods in the isolation hospital, and eventually died in an infirmary ward directly from dysentery. Another was in fourteen wards in four and a half years, including three periods in the isolation hospital, during the last of which she died. Another was in thirteen wards in fourteen months, including three periods in the isolation hospital, during the last of which she died.

Finally, a fifth patient was in thirteen wards in three years, and was never in the isolation hospital at all. Seeing that we have definite evidence, in the case of two laundrymaids at Hanwell, of a recurrent case being infective, we see how important this matter of transfers is; and it also shows the necessity of the system of notification which has been in force, as well as an efficient system for the separation of dysenteric patients from other patients. Moreover, it shows that great care should be exercised in the opening of new asylums, not to admit old cases who have had dysentery.

The Council at my suggestion have adopted a system similar to that adopted for suicidal cases, viz., a special parchment for dysentery and tubercle cases, which has to be signed by the attendants in charge of the case, so that a patient who has suffered with an attack of dysentery takes this parchment with him if he should be transferred to another ward or asylum, and in this way the doctors and attendants in charge will be always on the alert as to the case being a possible source of infection. (See next page.)

WATER, FOOD, AIR.

There is no reason to think that dysentery has spread in the London County Asylums owing to the water supply. A return of cases of enteric fever which occurred made it probable, from the data supplied, that this fever had been passed from one patient to another, in certain cases. The outbreak of dysentery, and the mode of its spread in particular, as I have shown, would suggest that it was also communicated from patient to patient in this way. The facts of the distribution and the occurrence of the disease are not in accordance with the supposition that it is acquired through the ingestion of unsound food, although it is highly probable that indigestible articles of food, e.g., pork, unripe and unsound fruit, may light up latent dysentery in individuals who have previously suffered. In certain asylums, e.g., Claybury, the drains were defective, and leaked into the subways; but, in-

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ARCHIVES

			lormitory
Asylum	•••••	*******	1903
CAUTION AS	s то Dyse	NTERY.	
Name Suffered from an attack of dysenter	у	State	
From to	• • • • • • • • • • • • • • • • • • • •		•
Relapses.	Ward, ii	No. of bed	Signature of Medical Officer in Charge.
From to			
From to			
From to			
From to			•
From to		•••	•
To the Charge Attendant, Ward			
(2) That it hang on a special of coom. (3) That every day and night Att. (4) That whenever fresh Attended in the construction of the constructio	tendant on delants come of the decision once a rawn by the I to this patisentery, and less, especial med motions even if unaccideal Officer in the patients.	ne wall in Ity in the ' In duty in week at a Medical Supent and un therefore in by weaknes i); loose in ompanied in order tha	ward reads it. the Ward, even i medical visit, and perintendent. nderstand that he must be carefully ss, blood, slime or notions extending by blood or slime t precautions may
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Care must be taken on the part of all Attendants to wash their hands after changing or handling clothes of patients, especially those suffering with diarrhœa or dysentery; to convey, in accordance with instructions, foul linen to proper receptacles; not to use feeding utensils of any kind for other patients which have been used by patients suffering with diarrhœa or dysentery, unless they have been thoroughly cleansed; in all cases to cleanse and disinfect the nozzle of enema syringes after use and to carry out all instructions of the Medical Officers for the prevention of the spread of the disease.

asmuch as outbreaks of the disease occurred in the summer and autumn, when this system of ventilation by air from the subways was not in use, it was not considered that the dysentery was directly associated with this cause. Moreover, the limitation of the disease to the patients, and the escape of the staff, except those who were in direct attendance on the patients, make a defective drainage system an improbable factor in the spread of the disease.

EFFECTS OF ISOLATION, NOTIFICATION, &C.

I am convinced that the continuance of notification, with relief of overcrowding and its dependent sanitary defects, the treatment of the cases like typhoid, with constant and minute attention to recognised modes of isolation on the part of the staff, attendants, and nurses in asylums where dysentery exists, will much abate the disease; and when cases do arise, either within the asylum, or from transfers or admissions, the spread of the disease will thereby be arrested.

A substantial support of the infective nature of the disease, and of the value of the adoption of the methods that are practised for the isolation of patients suffering with it, has been afforded at Claybury; and I am pleased to show evidence, obtained in the *post-mortem* room, indicating a marked diminution of the disease (vide p. 764).

Moreover, since the system of notification has been in practice, and attention thereby continually called to the disease, the number of cases reported from all the asylums has considerably diminished. It has not occurred in an epidemic form at Claybury now for some time, and a considerable number of the cases which have been reported have been old recurrent cases. Certainly I have lately seen very few indeed of the rapidly acute fatal cases that were so familiar to me on the *post-mortem* table before the enquiry took place (vide pp. 764, 765).

RELATION OF SPECIFIC MICRO-ORGANISMS TO THE DISEASE.

I have omitted reference to the relation of specific microorganisms to this disease, not because I do not highly value the importance of the recent researches of Flexner and his pupils upon the B. dysenteriæ of Shiga, but because Dr. Eyre kindly undertook to continue the observations which were commenced by the late Dr. Washbourne. The results obtained so far are inconclusive and require further extension before any reliable report can be made.

I have endeavoured to show in the foregoing pages that dysentery in asylums can and should be prevented, and those of my readers who may still cling to the old notions of the disease and its causation, I would refer to the discussion of my paper "Dysentery in Asylums," contained in the Transactions of the Epidemiological Society of London, vol. xxi., 1901-2. I was at that meeting asked by one of the Commissioners in Lunacy to give as wide publication as possible of the facts contained in it; therefore, with the permission and approval of the Pathological Sub-Committee, I have embodied much of what was contained in that paper in the present communication. But new facts confirmatory of my opinion with regard to the prevention of dysentery have been added, also more pathological data.

POST-MORTEM DYSENTERY STATISTICS. Claybury Asylum.

	SEPT. 1, 1898,	Jan. 1, 1899,	Jan. 1, 1900,	Jan. 1, 1961,	JAN. 1, 1902,
	TO	TO	TO	TO	TO
	DEC. 31, 1898.	DEC. 31, 1899.	Dec. 31, 1900.	DEC. 31, 1901,	DEC. 31, 1902.
	Deaths with	Deaths with	Deaths with	Deaths with	Deaths with
	Dysenteric	Dysenteric	Dysenteric	Dysenteric	Dysenteric
	Lesions.	Lesions.	Lesions.	Lesions.	Lesions.
Males.	8, primary cause in 5 cases.	26, primary cause in 14 cases.	9, primary cause in 2 cases.	11, primary cause in 5 cases.	1, secondary cause.
Females	21, primary	36, primary	34, primary	9, primary	19, primary
	cause	cause	cause	cause	cause
	in 16 cases.	in 14 cases.	in 21 cases.	in 8 cases.	in 8 cases.

Male Side. Up to the present time, January 20, 1903, there has not been a death with dysenteric lesions since May 3, 1902, and one previous to this, December 31, 1901. This compares very favourably with previous years, when cases occurred in batches of as much as four or five cases a month.

Female Side. A death with dysenteric lesions has not been seen on the post-mortem table since September 26, 1902; and during the year 1901 as much as four months elapsed between the deaths of two dysentery cases; whereas during the years 1900, 1899 and 1898, every month were accounted between one to eight deaths with dysentery.

SHOWING RELATION OF DEATHS WITH DYSENTERIC LESIONS, AND THE TOTAL DEATH-RATE AT CLAYBURY ASYLUM FOR THE LAST FOUR YEARS.

	SEPTEMBE: August	Верткивк 1, 1898, то А υсовт 31, 1899.	SEPTEMBER 1, 1899, TO AUGUST 31, 1900.	1, 1899, TO 81, 1900.	SEPTEMBER 1, 1900, TO AUGUST 31, 1901.	1, 1900, To 81, 1901.	September August	SEPTEMBER 1, 1901, TO AUGUST 31, 1902.
	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.
Total Deaths Deaths with Dysenteric Lesions	$118 \\ 22.96 \\ 27 \\ \text{p.c.}$	144 34·7 50 P.c.	116) 12 14) 'p.c.	$\begin{vmatrix} 136 \\ 23.5 \\ 32 \end{vmatrix}$ p.c.	$ \begin{array}{c} 79 \\ 8.8 \\ 7 \end{array} $	100) 15 15 15	83 8.43 7 P.c.	$\begin{vmatrix} 129 \\ 15.5 \\ 20 \end{vmatrix} \text{ p. c.}$
Total Deaths (Male and Female) Deaths with Dysenteric Lesions (Male and Female)	262 29.	29.4 per cent.	252 18·2	18·2 per cent.	179) 12·5	12.3 per cent.	$\begin{array}{c} 212 \\ \\ \\ 27 \end{array} \right\}$	12.7 per cent.

The above statistics probably represent the maximum, as the intestines were opened and carefully examined in every case. The dysenteric lesions refer not only to recent and active processes which in a large number of cases were the actual cause of death, but also to chronic, partially healed, or entirely healed processes, affecting the large intestine. The post-mortem examinations for the last three years have been made by either Dr. Bolton or myself, and the comparative statistics of these periods are therefore free from the fallacy of observations by different individuals.

DESCRIPTION OF FIGURES.

PLATE I .- Fig. 1.

Photomicrograph of polynuclear leucocytes from slime. Magnification 800.

Fig. 2.

Section of execum at junction with small intestine showing acute congestion and engorgement of vessels in the cutaneous coat, epithelial necrosis and exfoliation from a case of acute dysentery. Magnification 12.

Fig. 3.

Section of lower end of ileum showing villi; the vessels are engorged with blood, and it will be observed that the corpuscles are composed largely of leucocytes (polynuclear under a high power) stained deeply. Magnification 150.

PLATE II.-Fig. 4.

Descending colon. Case of acute dysentery showing the commencement of the formation of ulcers. The three distinct dark rings were caused by blood contained in a shallow trench in the mucous membrane, which was greatly thickened, and of a pale gray or dirty whitish colour.

Fig. 5.

Section of mucous membrane from the same intestine as fig. 4. The intense cell infiltration and exudation gives it the appearance of a diphtheritic membrane. A little circular patch (G) marks the position of the lower end of a tubular gland, but the epithelium is swollen up and in a state of coagulation necrosis. Magnification 250.

Fig. 6.

A later stage of the disease. Shows intense swelling of the mucous and submucous coats with formation of ulcers.

PLATE III.—Fig. 7.

Section of bowel from a case of chronic dysentery, showing small ulcer with undermined rounded edges, the floor formed by the submucosa. Magnification 10 diameters.

Fig. 8.

Transverse colon chronic dysentery, the walls greatly thickened and the lumen so large that it was thought to be the stomach during life. The circumferential measurement was twelve inches. The mucous lining presented a honeycomb appearance. (Reduced 3 times.)

Fig. 9.

Contracted rectum from a case of recurrent dysentery, showing wasting of the mucous membrane and prominence of the solitary follicles. (Reduced slightly.)

PLATE III.



Fig. 7.



Fig. 8.



Fig. 9.

THE PREVENTION OF DYSENTERY IN THE LONDON COUNTY ASYLUMS.

To follow Plate II.

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THE RANGE OF IMMEDIATE ASSOCIATION AND MEMORY IN NORMAL AND PATHOLOGICAL INDIVIDUALS.

BY W. G. SMITH, M.A.EDIN., PH.D.LEIPZIG, Lecturer on Psycho-Physics, King's College.

Introduction.

When we make the attempt to grasp a series of mental impressions we are soon met by the fact that there are definite limits to our capacity. Whether the series consists of words, or pictures, or musical tones, we can, as a rule, tell what we have seen or heard when the number of impressions is small. When, however, we try to grasp a larger number we are apt to feel uncertain and confused, and we realise the need of confining our attention to a smaller group, or of repeating the series again and again in order to master it. It is such facts as these, met with in our daily experience, that form the basis of the method adopted in the present research on normal and pathological individuals. The experiments which are to be reported form a section of the mental tests employed in the work which was carried on in the Pathological Laboratory of the London County Asylums, Claybury, during the year 1901.

It is obvious that experimental work with insane patients is subject to special conditions. The graver forms of disease do not lend themselves to this type of investigation; it is only the milder cases, and those which are recovering, that can be utilised. We may with care secure in such cases some degree of interest, attention, and understanding for the experiments. But we cannot control these factors to any great extent, and we are bound to make the conditions of work such that as little strain is put on their patience and their mental powers as is consistent with the attain-

ment of definite results. If we consider the method by which some of the best work on the subject of memory has been done, viz., the learning by heart of lists of nonsense syllables, we observe that this method seems in very many cases inapplicable. There is, however, another form of procedure which is more adapted to psychiatric experiments, and which has been employed in the present investigation. It consists in the presentation of objects of one kind or another to the subject, who is asked, either immediately or at some subsequent time, to recall as well as he can what was previously presented. The number and character of the errors in recollection which this method brings to light form an important guide to the nature of the associative and reproductive processes which are involved. procedure imposes no undue strain on the subject, and if the material presented be sufficiently simple he will be able easily to do what is required.

In working out this method with the patients, the first experiments were made with series of letters of varying length printed by the typewriter on small slips of paper. Each slip was handed in turn to the subject, who was asked after he had read it once, or in some cases twice, to hand it back and tell what he had seen. By this means there was no need of special apparatus, the use of which is probably disconcerting to some patients. The method, however, proved unsuitable, inasmuch as, apart from the variations in the ability to see and read, the subjects could not be relied on to read the letters exactly as often as they were requested The next step consisted in exposing series of letters by a falling shutter. The object of this modification was to keep the duration of exposure constant, while allowing the subject to vary the number of readings at his pleasure. The main difficulty was found in the fact that several of the patients persisted in reading the letters aloud while they were still exposed, in spite of repeated requests not to do so. Up to this time the use of auditory stimuli had been avoided for the reason that when isolated words or letters are spoken they are more liable to misapprehension than visual impressions would be; but in view of the difficulties already

mentioned it was decided to employ auditory impressions. The difficulties attendant on their use did not as a matter of fact prove considerable, and there is this definite advantage that the act of speaking seems specially well fitted to catch and keep hold of the attention of the subject. Numbers were not utilised in forming the series lest some persons might show an aversion to anything connected with arithmetic. The letters of the alphabet are simple and known to everyone with the slightest beginnings of education; they offer very numerous combinations, and, though exciting little interest, may be assumed to be of approximately equal interest to everyone.

Investigations on normal subjects in which auditory impressions, including words, syllables, numbers and letters were presented, have been made by Jacobs, 1 Bolton, 2 Bourdon,3 Binet and Henri.4 The first use of the method in studying mental disease appears to have been made by Rieger; it was employed by him in a somewhat simple form, first in analysing a case of general paralysis of the insane,5 next in a case of severe mental disturbance due to a railway accident. In the paper describing the former case it was pointed out that the inability of the patient to repeat fairly long words and combinations of letters and figures was not due to any defect in articulation, but to his inability to retain a connected series of impressions. In 1886 Galton examined the mental range—the "prehension"—of idiot and imbecile children by a method resembling that of the present investigation.7 The importance of testing patients in regard to their power of acquiring new impressions and ideas-Merkfähigkeit—has been emphasised by Wernicke,8 and Kræpelin.9

[&]quot;Experiments on Prehension," Mind, xii., O.S.
"The Growth of Memory in Schoolchildren," Am. Journ. of Psych., v.
"Influence de l'âge sur la mémoire immediate," Rev. Philos., xxxviii.
"La mémoire des mots," L'année psychol., i.
"Cur Kenntniss der progr. Paralyse," Sitzgsb. d. phys.-med. Gesellsch., Würzburg, 1884, 1885.

^{6 &}quot;Beschreibung der Intelligenzstörungen in Folge einer Hirnverletzung," Verhall. d. phys.-med. Gesellsch.. Würzburg, 1888.
7 "Supplementary Notes on Prehension in Idiots," Mind, xii., O.S.

^{*} Grundriss der Psychiatrie, s. 76. ⁹ Psychiatrie, i., s. 127 (6te Aufl.).

METHOD AND PRINCIPLES OF ANALYSIS.

In the construction of the series, which were to be read aloud to the subject and reproduced by him orally, the following precautions were used. Each letter was written on a small card, the vowels being represented twice, and the cards were formed into a pack. After the cards had been shuffled they were taken up one by one, and the series of letters arranged according to the order in which the cards appeared. It was not advisable, however, to allow the order to be determined entirely by chance; this would have resulted not infrequently in undesirable combinations, e.g., the accumulation of vowels and the sequence of letters following each other in the alphabet. Accordingly the arrangement given by chance was modified, so that the vowels were separated by at least one consonant, while only in a few of the longer series was a letter repeated. In a small number of cases two consecutive letters were separated by one other letter; in the majority of cases two or more other letters intervened. No attempt was made to modify the larger aggregations of consonants, or the combinations which were difficult of articulation, or to alter the arrangement where the letters seemed to suggest an intelligible word. As a matter of fact the last-mentioned difficulty was prominent in only one instance, and in this case the combinations of letters which gave rise to the association were usually such as would hardly have been thought to be dangerous. For our purposes these and other difficulties were of minor importance, seeing that the chief aim of the investigation was not to secure final determinations of the different factors involved, but to afford a basis for determining the value of the method in its application to pathological psychology, and for securing comparative results. For this purpose the most important requisite was that normal and abnormal reagents should be tested as far as possible under precisely similar experimental conditions. Only in a few isolated instances were the same series used over again with the same subject; on the other hand the series given to normal and abnormal subjects were practically the same.' There would in these experiments have been little danger in a more extended use of the same series, for the combinations of letters disappear so quickly from memory that after the lapse of a very short time all traces of the former presentation would have vanished. But the employment of different series each time makes it more certain that the different factors which become prominent in the final results are not due to any special combinations of letters.

Uniformity in the presentation of the series was secured by the use of the metronome; the pronunciation of each letter by the experimenter was made to coincide with a beat of the metronome; the rate used in all cases being 108 beats in the minute.2 Rhythm in speaking was avoided as far as possible. As a rule, no signal was given beyond the starting of the metronome when the subject was attentive; a pause extending over several beats was always made before the experimenter began to pronounce the letters. actually employed with all the reagents, except three, varied in length from four to ten letters. Preliminary experiments had shown that three letters were too easy; ten letters, on the other hand, would certainly be too much for the ordinary person, normal or abnormal; somewhere between four and ten letters would be found the point where the capacity of reproduction broke down. Series varying in length from six to twelve letters were given with the three subjects referred to above, for the reason that these individuals were plainly capable of remembering a larger number of letters. The extension of the test to ten and to twelve letters was meant to supply data for an answer to the question—What precisely happens when the mind is called on to master in this way something which decidedly exceeds its capacity? In such an effort there will obviously be considerable disorder in the reproduction; it is quite conceivable that this disorder or dissociation is of a character similar to that

¹ The principle of Gleichheit der Reize, which, according to Sommer, Lehrbuch der psychopathologischen Untersuchungsmethoden, is of fundamental importance in pathological investigations, is adequately recognised in such experiments, not by identity, but by similarity of stimuli.
² For a discussion of the effect of various rates, v. Bourdon, loc. cit.

induced in our permanent memories by lapse of time, or fatigue, or the degeneration of the nerve-cell. case, with one exception, the series presented first was the shortest, the others being given in regular order after it, e.g., after the series of four letters came one with five letters, and so on till the limit was reached.1 In this way the reagent, beginning with what was easy, gained confidence for the attempt to remember the longer series. individuals the beating of the metronome was a distraction; the general answer given when inquiry was made was that the disturbance was not appreciable. In one instance only (referred to again later on) was this factor of material importance. It will be readily understood that it was not advisable to exhaust the patience and goodwill of the subjects in preliminary experiments for practice. An estimate of the magnitude of this factor will be given later on in the paper.

The general elements which enter into the complex psychological activity involved in these experiments may be briefly indicated as follows. There is first the reception of the sound impressions in consciousness, and concurrently with this their interpretation and recognition through the processes of association. To the full and unimpeded exercise of these processes there are necessary, we may suppose, not merely an intact sense organ with afferent tract and central projection sphere, but also an efficient system of associative paths or fibres connecting the auditory sphere with those for vision and speech. A certain degree of attention is essential, and a somewhat high degree is advantageous, inasmuch as the attentive attitude brings with it greater intensity and clearness of the presented impressions and the heightened associative and reproductive power which these It is important to emphasise the fact that what we attend to and seek to recall in these experiments is not mere isolated impressions, it is a series, a connected group. thing that we measure is not simply the power of attending to individual objects passing into and out of consciousness,

¹ In what follows it will often be convenient to refer to the series, according to the number of letters they contain, as *stages*; thus a series containing eight letters will be termed the stage of eight letters, or the eighth stage.

but the ability to grasp a number of objects as a connected system. The explanation of the definite limits to which this ability is subject is to be found, no doubt, in some limitation of the underlying cortical processes. But so far as our knowledge goes there does not seem ground for deciding whether the limitation lies in the number of cells and fibres involved, or in the supply of energy available in the cells at each moment. If we assume that there is a definitely limited system of cortical processes called into play by the presentation of a series which is just within our power, the question may be asked, Is each part of this cortical system represented in consciousness? In other words, do all the members of the presented series exist together in consciousness for the moment, partly in a clear, partly in an indistinct form? From the point of view of theory, an affirmative answer is possible; it seems, however, far more probable that our consciousness illumines, so to speak, only part of the cortical system, the other parts being connected with this by the ordinary associative and reproductive bonds. The last factor, that of the more purely reproductive processes preceding the subject's response, may be explained as being due to the reawakening or increased excitation of the psychological processes already spoken of, which in turn issues in a markedly increased excitation of the centre for speech. With the exception of the processes last mentioned, the activities referred to constitute in general the initial stage of memory.

In the absence of experimental work dealing with the detailed analysis of the reproductive processes in the insane, it was necessary to carry the analysis of the experimental results as far as possible, so that no factor of importance which might be brought to light by this method might remain unnoticed. The various divisions which are used in the following scheme are not, it may be remarked, the outcome of theoretical reflection, but are simply the expression of features in the results which are actually met with in the course of observation. Obviously the most important feature is the number of letters which are reproduced exactly in the position in which they stood in the original or presented

series. The determination of this value gave rise to some rather difficult problems, since, especially with the insane, the total number of reproduced letters at the later stages often fell short of, or exceeded, the original number. In the great majority of such cases no indication was given of the proper relations of the letters, and it was highly inexpedient to disconcert the reagents by repeated questioning on the subject. The following solution of the problem was finally adopted. In the absence of any indication on the part of the reagent, give the reproductions the highest value which can be obtained by determining the position of the letters in any of the following ways. (a) The reproduced series may, if too short, be treated as if the letters ran continuously from the beginning onwards (omission assumed to be at the end), or from the end backwards (omission at the beginning), or from both beginning and end to a point lying somewhere between: not more than one omission was allowed, i.e., all the omitted letters were supposed to lie together at one place. (b) If the reproduced series is too long. then again it may be read forward, or backward, or from beginning and end to some one point lying between. On the whole this treatment probably gives too high a value to the results, but it satisfies an urgent want in the course of analysis, viz., the need of a definite method of giving credit for scattered fragments of the original series, which it would be wrong to put out of the class of right letters when their position is not definitely indicated by the subject. In this kind of reproduction we may speak of the letters as rightly placed (1).

To illustrate these and other points, we will suppose that in all cases a series of seven letters has been presented to the reagent, viz., a b c d e f g. One reagent reproduces a b c d e, while another gives a b c d k l e f g. In the former case by placing the omission at the end, in the latter by supposing the added letters to lie between d and e, we are able to give a high value to both reproductions. The disadvantage of giving too great value in the latter case, where

¹ The numbers and the descriptive terms used here and in what follows are the same as those employed in the tables given subsequently.

all the letters are treated as correct, is minimised by making excess a separate class of error.

The analysis takes account next of reproductions in which we may trace partial association, or what comes to the same thing, partial dissociation and disorder. Three forms of this general type of error have been distinguished. (a) A group of letters, each of which retains its proper place in the group, is put in a wrong position; e.g., a b c is put at the end instead of at the beginning of the reproduced series; we may speak in this case of a group transposed (2a). (B) The letters in a group mutually change places, or suffer inversion, while the group as a whole retains its proper place; this is termed inversion in right position (2b). (y) The group of inverted letters may be in a wrong position; this error is committed, for example, when the combination of letters b a is put in the middle of the series. termed inversion in wrong position (2c). The last of these three forms of disorder is on a lower plane than the others, but all three are to be sharply distinguished from cases in which there is no trace of the original position of a letter; such letters are termed wrongly placed (3). Lastly, we note that the letters in the original series may be simply omitted; where this error of omission (4) occurs it is evidence of the deepest kind of disorder.

These six divisions complete the list of changes in the original series, which have been taken into account in the analysis. But there are other important forms of error. Letters not presented in the original series may be added or inserted in the reproduced series; this error is termed insertion (5). Again, letters may be erroneously repeated. In this case two minor types make their appearance: (a) a letter which was in the original series may be repeated, or (b) a letter which is "inserted" may be repeated. Since, however, both types exhibit the same tendency, viz., that of repetition (6), they have not been separately estimated. Where the instances mentioned under (b) occurred, the first letter reproduced was put in the class of insertions, while the second was considered to be a repetition; in this way both the tendencies which are actually operative receive due

ecognition. If we take correct and incorrect letters together and compare the total length of the reproduced with that of the original series we find, as before remarked, that the two, while usually equal in the earlier stages, are very frequently unequal in the later stages. Where too few letters are given we may call the error one of defect (7); where, on the other hand, too many letters are given, the error is one of excess (8). It is clear that both tendencies are significant, and the average has been worked out for each, separately. In conclusion, it may be remarked that the practical work of dissecting the reproductions is much more complex than it appears in this general explanation. The interpretation of the results is, in not a few cases, difficult, but the general principles laid down are clear and reasonable.

NORMAL RESULTS.

The normal results which will be given first are intended to serve as a basis for estimating the character of the results gained from patients in the asylum; they were obtained from eleven individuals—nine men, two women—the majority of whom were between the ages of 20 and 30. Had it been practicable it would have been more satisfactory to secure persons somewhat older, in order to allow of a more precise comparison with the pathological individuals. Probably, however, the factor of age is in itself, without other complicating elements, one of the less important. The youngest of the normal subjects (age 21) gives one of the lowest results; on the other hand, the oldest of all the subjects (age 65), a patient in the asylum, gives very high figures. The results from the eleven normal subjects are arranged in two groups. The first group (A) contains all the experiments made with series containing four to ten letters; the nine persons who contribute these experiments—seven men, two women—are, with one exception, attendants or nurses in the Claybury Asylum, whose grade of education and intelligence may be taken as being probably on the average not unlike that of the abnormal subjects before their illness. All have contributed results on two or more days; all have given fifteen or more

experiments at each stage. In every case except one the experiments were made between the hours of three and five in the afternoon; there was, as a rule, an interval of a fortnight or more between the days on which the laboratory work was done. In the second group (B) appear the experiments contributed by two men who have had a much more thorough intellectual training, and who were exceedingly competent subjects; the series used with them were different from those used in the former group, and varied in length from six to twelve letters. The experiments in this group were unavoidably somewhat irregular. In the case of the first of these subjects one day of special vigour is to be set against several periods in which the fatigue caused by other occupations and by severe night work was felt; there was irregularity also in some other minor features; the final result, I was assured, would give a fair average. In the case of the other subject, the larger number of experiments were carried out in a private house, and, except on one day, the rate of presentation was kept constant, not by the metronome, but by a small clock: the majority of the experiments were carried out in the evening, and were undoubtedly somewhat influenced by fatigue. In this case the different stages were presented in an arbitrary order, designed to prevent the immediate sequence of series which differed in length by only one letter. This procedure, which, with trained reagents, offers certain advantages, did not seem either necessary or advisable for the general purposes of the research; its usual effect, probably, was a lowering of the value of the reproductions. The persistent but quite involuntary tendency to associate intelligible words with the letters, which this reagent experienced, was on the whole, according to his statements, hindering rather than helpful, owing to the distraction which it occasioned.

In the first four of the tables which follow are given the Table I. contains the data of group Afinal average results. (nine reagents; series from four to ten letters). ages for each individual were first calculated and then used as the basis for finding the general average; in this way each result in the general average represents 157 observations. The Roman numerals in the uppermost horizontal column refer to the number of letters given at each stage.

Table I.—Group A. General Normal Results.

	IV.	v.	VI.	VII.	VIII.	IX.	X.
(1) Rightly placed	3.9	4.7	5.0	5.1	5.2	4.5	4.7
(2a) Group trans-) posed)		-		0.1	0.2	0.5	0.5
(2b) Inversion in right position		0.2	0.3	0.5	0.4	0.4	0.3
(2c) Inversion in) wrong position							
(3) Wrongly placed	–		0.1	0.2	0.5	1.0	1.1
(4) Omission	0.1	0.2	0.5	0.8	1.5	2.4	3.1
(5) Insertion	–	0.1	0.4	0.5	0.7	0.8	0.8
(6) Repetition			0.1	0.2	0.4	0.7	0.8
(7) Defect			0.1	0.2	0.4	0.9	1.5
(8) Excess	-		0.1	0.1			
M. V	0.1	0.2	0.5	0.6	0.9	0.8	1.1

Table II.—Group A. Percentages.

•		IV.		v.	VI.	VII.	VIII.		IX.	X.
(1) Rightly placed	• •	97.8	• •	93.4	 83.7	 73.5	 65.3	• •	49 · 9	 47.1
(2) Partial disorder		0.8	••	3.4	 6.5	 11.3	 9.8	• •	13.6	 11.0
(3) Wrongly placed		0.3		0.4	 2.0	 3.4	 6.3		10.6	 11.2
(4) Omission		1.3		3.0	 7.7	 11.9	 18.8		26.1	 30.7

The meaning of the terms used in the vertical column at the left hand has already been explained; the figures in each horizontal line indicate the magnitude of the errors at each stage. The lowest horizontal column gives the mean variation (M.V.) of the general average of rightly placed letters, i.e., the average deviation at each stage of the individual results from the general average. While the figures in this table represent absolute values, the figures in Table II. represent the more important of these values in a relative form, i.e., expressed as percentages. The columns 1, 3, 4 of this table correspond to the similarly named columns in Table I.; column 2, partial disorder, on the other hand, gives the expression in percentages of

the sum of the results in columns 2a, 2b, 2c, Table I. Tables III. and IV., which contain the data of group B, are constructed on the same plan as Tables I. and II.; each result represents thirty-nine observations. The figures in these and other tables have been given only to one place of decimals. In doing so we lose sight of some of the finer shades of difference. But in giving too great a mass of detail the more important general relations tend to be obscured, while the extent of representation given to single observations, and consequently to the play of accidental factors, is unduly increased.

Table III.—Group B. General Normal Results.

	VI.	VII.	VIII.	IX.	x.	XI.	XII.
(1) Rightly placed	5.8	6.7	7.1	7.2	6.6	5.9	5.7
(2a) Group transposed			0.1	0.1	0.5	0.9	0 ·8
(2b) Inversion in) right position		0.1	0.4	0.5	0.4	0.4	0.1
(2c) Inversion in) wrong position			0.1	0.4	0.2	0.2	0.4
(3) Wrongly placed		-	0.1	0.3	0.9	1.4	1.8
(4) Omission	0.2	0.2	0.3	0.7	1.4	2.3	$3\cdot 2$
(5) Insertion	0.1	0.1	0.2	0.3	0.4	0.6	0.6
(6) Repetition	–	–	0.1	0.2	0.3	0.6	0.9
(7) Defect			0.1	0.3	0.7	1.1	1.8
(8) Excess	-	–		0.1			

Table IV.—Group B. Percentages.

	VI.	VII.	VIII.	IX.	X.	XI.	XII.
(1) Rightly placed	 97.0	 96.3	 88 ·9	 79.7	 66.1	 53.4	 47.7
(2) Partial disorder	 	 1.7	 6.5	 10.2	 11.3	 13.3	 10.8
(3) Wrongly placed	 	 	 0.8	 3.0	 8.6	 13.1	 14.9
(4) Omission	 3.0	 2.1	 4.1	 7.3	 14.2	 20.5	 26.7

A generalised expression of the extent to which the individual subjects vary from the general average in regard to

¹ In all cases, except where otherwise stated, the individual and general averages for each column have been calculated to two or more places of decimals in the preliminary tables. The numbers which appear in the tables are gained by reducing each result taken by itself to one place of decimals. It is evident that in this process of reduction slight irregularities must be introduced.

rightly placed letters has already been given in the mean variation introduced in Table I. It had been intended to insert the detailed figures for each individual, but owing to lack of space they have been omitted. An idea of the character of the individual results may, however, be gained from the data included in Table V.¹ The column of absolute totals in this table gives the sum of the rightly placed letters at all the stages taken together for each person in group A; the other columns give the probable error for each person, at the sixth and ninth stages, of his average of rightly placed letters. By means of these data a comparison can readily be made with the corresponding pathological data in Table XII.

TABLE V.—Group A.

_	R.	В.	Pr.	C.	Wh.	F.	Wm.	М.	н.
Abs. Totals	30.8	32 ·8	34.1	27.3	34.6	34.5	27.1	42.9	34.3
Prob. Err., VI	0.2	0.1	0.2	0.3	0.2	0.2	0.4	0.1	0.1
Prob. Err., IX	0.3	0.2	0.2	0.4	0.2	0.3	0.2	0.3	0.4

We have now before us material for obtaining some conception of the ordinary person's power of recollection under the special circumstances of this investigation. We have all the differences due to age, sex, culture, and personal ability represented in the tables, but in the average we have a sort of composite photograph in which accidental irregularities are largely eliminated, while the general characteristics are made prominent. The individual differences, it will be remarked, show themselves more markedly the more difficult the task becomes; the mean variation in Table I. increases from 0·1 at the fourth stage to 1·1 at the tenth stage.² The guarantee that the individual averages do represent a definite and fairly constant capacity is to be found in the probable

^{&#}x27;In calculating the probable error in Tables V. and XII., the variations from the arithmetical mean were taken to one place of decimals.

² In a paper on "The Place of Repetition in Memory," Psychol. Rev., iii., I have pointed out an analogous relation in the fact that when reagents are memorising nonsense syllables the mean variation of the general average after twelve repetitions is nearly three times what it is after one repetition.

error of Table V. The fact that two normal persons (C. and Wm.) are conspicuously low in the series of absolute totals, Table V., is only an illustration of the common experience that the dividing line between normal and pathological phenomena is often hard to draw definitely; these two cases may be taken as showing that the general average is not pitched too high. The person who gives the highest values in group A, and who gives the highest value of all at the tenth stage, is a nurse who received only the common board school training in a country parish; this fact gives the proof that success in these experiments is not simply a matter of education.

It is an interesting circumstance that Tables I. and II. correspond in almost every general feature with Tables III. and IV., with the exception that the values in the latter tables are decidedly higher than in the former. In this agreement we have a valuable guarantee for the validity of any conclusions which we may draw from the figures. Owing to the different height of the averages in the tables, we secure a higher and a lower standard; this circumstance is of value when we attempt to estimate the nature of the pathological results in different individual cases.

It will be observed that in both Tables I. and III. there is a rise in the value of rightly placed letters from the first point on till an absolute maximum is reached, after which the numbers diminish; in the one table the maximum lies at the stage of eight letters, in the other at the stage of nine letters. If we turn to the relative values given in Tables II. and IV. we find on the other hand a decrease which is continuous, though with a varying rate. There is a curious feature in the first table, viz., the recovery at the tenth stage; that this is not merely accidental is shown by the fact that if we reckon up the number of individual cases in which the phenomenon occurs we find that it is present in two-The explanation is perhaps to be found in the hypothesis suggested by one of the reagents, whose results showed a recovery, that at the later stages, since all could not be grasped, there was an involuntary mental tendency to take firmer hold of a smaller number of letters.

be suggested that that part of the rise is due to the fact that with increase in the length of the series any letter reproduced by chance has a greater probability of being correct. It is to be noted, however, that the tendency to reproduce letters at random was markedly absent in all the experiments.

Inasmuch as the column of rightly placed letters takes into account every single letter which happens to be in the right position, whether it stands isolated or in combination with other correct letters, the data presented in these tables do not give a sufficiently clear answer to the question:—What is the actual normal limit of the range of accurate memory? We can, however, secure additional evidence on this point by finding what proportion of the series reproduced at each stage is correct in every detail. This has been calculated for each individual, and the figures, expressed as percentages, have been combined to form a general average. For group A the results are as follows:—

The figures for group B are not so clear, inasmuch as the limit for one subject lies at eight, and for the other at seven letters. For this reason the fall is more gradual.

VI. VII. VIII. IX. X. XI. XII.
$$82 \cdot 1 \dots 79 \cdot 8 \dots 55 \cdot 7 \dots 35 \cdot 2 \dots 18 \cdot 9 \dots 9 \cdot 1 \dots$$

Taking the data for the first group we see that a decided fall of the curve occurs in passing from the fifth to the sixth stage. To put the matter in another way, more than half of the reagents show the most decided decline at this point. This mode of calculation, however, cannot show how definite are the limits of the mental range, how decided the break is when it occurs. This can be made clear in another manner. When we arrange on one side the two values which precede

¹ It will be noticed that there is a second distinct fall between the eighth and ninth stages. By another series of calculations it has been determined that this diminution represents the point (1) where the individual as a rule fails altogether to give quite correct reproductions, (2) where at the same time he first shows a marked lessening in the absolute number of rightly placed letters. In other words it is at this point that the additional or residual effort, referred to later on, shows distinct signs of failure to attain its object.

the first marked fall, and on the other side the two values which follow, irrespective of the stage at which in the individual cases the fall occurs, we get the following general result for group A:—

$$93.0 \dots 79.6 \quad - \quad 35.2 \dots 18.6$$

In other words, while there is a decline preceding and following the fall of 10-20 per cent., there is a diminution at the fall of 40-50 per cent. In the second group the fall amounts to 47 per cent.

If we compare the figures representing the three types of partial disorder (2a, 2b, 2c), with those representing the more gross forms of disorder (3-8) in Tables I. and III., we observe that, while in the latter errors there is in general a steady increase up to the last stage, the former seem much less regular. When, however, we look at the relative values in Tables II. and IV. we notice that while the latter errors (3, 4), still show an increase, the former, taken together (2), do not show any well-defined increase or decrease after a certain point which is in the neighbourhood of the absolute maximum of rightly placed letters. In other words both groups, A and B, show, after a certain stage, relative constancy of partial disorder.

The error of transposing a group of letters (2a) is not noticeable in the earlier stages, and after reaching a maximum at the second last stage in both groups, begins relatively to diminish. The error of inverting letters in the right position (2b) shows several peculiar points. is among the first to reach a noticeable magnitude; it reaches its absolute and relative maximum near the highest absolute magnitude of rightly placed letters, and then undergoes a marked decrease. On the other hand inversion in a wrong position (2c) shows an irregular absolute increase; from the relative point of view the increase is also irregular. The only curves of error directly affecting the letters of the original series, which show unquestioned regularity, are those of wrongly placed letters (3) and omission (4); in these there is increase both absolutely and relatively.

If we assume the existence of a definite cortical system,

with a certain amount of energy available at each moment for the work of memory, the main features of these results become intelligible. The range of memory varies with the inherent capability of the reagent; but within the limit, as we have seen, we can count on 80 to 100 per cent. right answers; when the limit is passed we can still count on 30 to 40 per cent. right answers. After the limit is reached, our energy is not completely used up, but the point of maximum efficiency has been passed; we can with an effort do more, but the result is much more uncertain and liable to contain error. The errors of wrongly placed letters and of omission might be expected to increase, as they do. The increase in the total of rightly placed letters up to the eighth stage in Table I. is partly due to the residual effect of the effort, partly to the combination of results from individuals whose memory limit is different. The relative constancy of partial disorder may perhaps be taken to signify that while there was not enough energy to establish complete association, it was yet sufficient to establish a large and fairly constant number of incomplete associations. The errors of transposition and of inversion in right position become prominent according as the energy fails to be equal to its task; being comparatively high types of partial association, they also begin to decline later on.

Errors of insertion (5) resemble those of repetition (6) in so far as both involve confusion between what was given and what is merely imagined—a form of paramnesia. It must, however, be noted that the error of insertion owes its early appearance in the tables partly, in all probability, to defective apperception, *i.e.*, misinterpretation of what is heard. In the former error, we have the substitution of new for old; in the latter a continued activity of elements already excited—a sort of cortical positive after image. Both errors will tend

on the part of the students.

² Cf. observations by Müller and Pilzecker on "Die Perseverationstendenzen der Vorstellungen," Zeitschr. f. Psych. u. Phys. d. Sinn., Ergänzungsband I., (Experimentelle Beiträge zur Lehre vom Gedächtniss), s. 58.

¹ That the error in the present case was not due to defective presentation is clear, not merely from the remarks of the subjects, but from the fact that at the earlier stages the error was not unfrequently altogether absent. Care was taken that the experiments should not be vitiated by imperfect hearing on the part of the subjects.

to appear when a cortical system which is inherently illdefined and uncoordinated, or whose limit has been passed, is strongly stimulated in the effort to give a complete answer. When the task is much too great, as at the last stages, the effect may be bewildering and inhibiting rather than stimulat-This may explain the fact that the error of insertion shows a relative decrease at the last stage. The phenomenon of excess (8) becomes noticeable only in the intermediate stages; its appearance is probably due to the same factors as those which cause insertion and repetition; its disappearance, on the other hand, at the latter stages may be connected with the increase of the error of defect (7), both being evidence of the inhibitory process referred to above. It will be observed that the errors of omission and of defect may each be the expression of two different mental states. The subject may be aware that he has given too few letters, or, on the other hand, his recollection of the original series may be so imperfect that, though he has given too few letters, he supposes himself to have reproduced all that were presented.

The character of these results is no doubt modified in some degree by the nature of the subject's mental imagery. The fact that the reproduction was always oral has probably also some influence. A number of experiments were carried out with visual impressions, which were reproduced in written form, but the data are not sufficiently numerous to allow them to be compared with those gained by the foregoing method. From observations made in the present investigation, as well as in the course of a former research, I am inclined to believe that the modification of the actual results by varying imagery is not very great. Different persons have different methods of remembering, but the results may be very much alike.

¹ Three of the normal reagents were tested in this way; the results of the only one (Group B) who was able to carry out a large series of experiments are as follows:—

VI. VII. VIII. IX. X. XI. XII. Rightly placed .. 5.9 .. 6.2 .. 6.9 .. 6.8 .. 5.3 .. 5.6 .. 4.8 (Five days, 15 expts.)

The results are very similar to those gained with this reagent by the auditory method.

PATHOLOGICAL RESULTS.

The report on the pathological section of this investigation includes results gained from thirteen patients in Claybury Asylum—nine men and four women. considerably in regard to the degree in which their mental powers are affected; all were able, however, to understand what they were asked to do, and were in almost every case willing to do what they could. All have had some measure of education. Their ages vary considerably; on the whole they are older than the normal individuals. All the patients gave experiments on at least three separate days; in some cases the interval between the days was a week, in the majority of cases it was a fortnight or more. With the exception of one case all the experiments were made between the hours of three and five in the afternoon. All the men except one were smokers, and I found it useful to give them tobacco when the experiments were over for the day, and in some instances during the experiments also. The experimental procedure was in all respects, as far as practicable, the same as that employed with the normal subjects. will be observed that a number of the cases are somewhat complex, as so commonly occurs in mental disease; this has been a difficulty in the way of classification. Three groups have been formed, each of which presents some common features. The individual results are given in part, as well as brief notes of the individual histories, so that it is possible to see how each individual is related to the group in which he is included.

PATHOLOGICAL GROUP I.

The first group includes three men suffering from general paralysis of the insane. They are in a relatively early stage of paralytic dementia, all show marked physical signs of the disease; all have had syphilis. The group seems homogeneous, not merely in regard to the character of the disease, but in regard to the extent of mental deficiency. Each person shows an absolute total of correct reproductions

RANGE OF IMMEDIATE ASSOCIATION AND MEMORY 787 which is below that of the lowest normal subject (vide Tables V. and XII.).

J. D., aged 51, single; has been in business and has also been an artist of merit; in asylum over two months, but was in another asylum before being transferred to Claybury. Compared with his previous life, his present condition is exceedingly childish. He has a high opinion of his artistic power and is continually beginning work which he is unable to carry out even in an amateur manner: rubbish is stored up as something valuable. His memory for the past is apparently good. During the laboratory work he is rational and coherent in his remarks, but talkative and impatient. At the first he is very ready to do the experiments; later on, finding his memory unexpectedly weak, he asks to have only the easier series given and finally becomes very unwilling to go on. The results should be compared with those of Table III. as well as those of Table I.

I. S., aged 37, married; has been a clerk and has also been connected with the turf; in asylum (second time) a year and a half; his brother died insane. He is occasionally depressed, making attempts at suicide; at other times he is violent, irritable, and spiteful; he has unsystematised delusions of grandeur. His memory for the past is good. During the laboratory periods he is very talkative, telling long and rambling stories, partly about his own ability to do everything perfectly, partly about the persecution he has undergone from relatives. As a rule he is cheerful, fairly attentive and exceedingly anxious to be polite and obliging.

S. S., aged 53, single; has been in business as money-lender and publican, has travelled in the tropics; in asylum nearly half a year. He suffers from occasional severe seizures almost epileptic in type; one of these occurred a few days before one of the visits to the laboratory. His memory for the past is fair but uncertain. He sits in the same chair all day, or wanders within a few yards of the same spot. He is willing and attentive throughout the

¹ Here as in the case of all the following pathological subjects I have inserted the average of rightly placed letters, the number of days on which experiments were made, and the total number of experiments at each stage.

experiments; though occasionally ready to talk, he is generally dull, making no movement and offering no remarks.

Rightly placed ..
$$3\cdot6$$
 .. $4\cdot1$.. $3\cdot7$.. $4\cdot0$.. $2\cdot6$.. $2\cdot5$.. $2\cdot4$ (Three days, 20 expts.)

The most prominent characteristic in the results of this group is the marked and uniform lowering of the number of rightly placed letters; at the ninth and tenth stages in Table X. the number is about 20 per cent. below that of

	TABLE	VI	-Pathol	ogical	Group .	<i>I</i> .	General	Results.
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			-				
	IV.	V.	VI.	VII.	VIII.	IX.	X.
(1) Rightly placed	3.6	4.3	4.1	3.7	3·4	2.7	2.5
(2a) Group transposed				0.4	0.5	0.6	0.6
(2b) Inversion in) right position	-	0.3	0.5	0.4	0.3	0.5	0.3
(2c) Inversion in wrong position	-	-	-	0.2	0.3	0.2	0.3
(3) Wrongly placed			0.3	0.9	1.2	1.7	2.0
(4) Omission	0.4	0.3	1.1	1.5	2.4	3.3	4.3
(5) Insertion	0.4	0.3	0.8	1.0	1.2	1.3	1.3
(6) Repetition	-		0.2	0.4	0.6	0.9	0.8
(7) Defect			0.3	0.3	0.7	1.2	$2 \cdot 2$
(8) Excess	–	0.1	0.2	0.2	0.1	0.1	0.1

Table VII.—Pathological Group I. Percentages.

		IV.	V.	VI.	VII.		VIII.	IX.		Х.
(1) Rightly placed		90.0	 86.6	 68.4	 53.0		41.9	 29.7	• •	24·5
(2) Partial disorder	••	0.8	 6.6	 8 ·5	 13.4	٠.	14.0	 14.1		12.8
(3) Wrongly placed		0.5	 0.4	 5.0	 12.7		14.4	 19.2	••	19.7
(4) Omission		8.8	 6.4	 17.8	 20.9		29.9	 37·0		43.0

Table I., and about 40 per cent. below that of Table II. If we take the numbers representing the percentage of series reproduced quite correctly we find similar relations.

These figures would be still lower were it not that the subject, J. D., at the fifth and sixth stages gives an unusually large number of quite correct reproductions. The columns in Table VI. indicating omitted and wrongly placed letters

are about 10 per cent. below the normal at the last two stages. When we turn to the column representing partial disorder in Table VII., we are met by two noteworthy facts. From the seventh stage on, the proportion of partial disorder remains approximately constant as in the normal tables; that proportion is only slightly higher than it is for the normal subjects in Tables II. and IV. The minor groups of partial disorder (2a, 2b, 2c,) show nearly the same magnitudes and the same form of curve as do those in the normal The error of insertion is much larger than it is in the normal results; repetitions are more numerous. There is increase also in the columns of defect and of excess. general then it may be said that the mental range is diminished, and that in all the columns indicating the more gross forms of disorder, the magnitudes are greater than with normal subjects, though the form of the curve remains similar; on the other hand, the columns indicating partial disorder show no distinct pathological feature.

PATHOLOGICAL GROUP II.

The second group includes three men and one woman. All are suffering from general paralysis of the insane, but the disease, though varying in the different cases, is much less marked than it is in the first group. Tabes dorsalis is present in all the male cases. Alcoholic excess is found in the previous history of three of the patients, but the effects of this factor appear to be subordinate at the time of the investigation.

R. S., aged 36, single, well educated; was formerly clerk in public and private offices, and has also made a living as hawker. His history includes alcohol and syphilis. In asylum two years; his mother and brother have been in asylums. He has an elaborate group of delusions, in which electricity plays the chief part. A woman has attempted to poison him, has power over his body, and is constantly acting on him by electricity, pulling at his legs, telephoning words to him, and taking away his thoughts. He constantly hears voices in the various noises that are made in the ward, and covers his head with bedclothes at night to get rid of them. Soon after beginning the experiments he complains that

he hears a voice in the beating of the metronome: owing to this the experiments are continued without the metronome, except for test experiments occasionally made to find whether the voices still persist. A comparison of the result with and without metronome shows such small and irregular differences that all the experiments have been taken together in the report. His memory for the past is good. He is willing, attentive, and intelligent, and looks on the laboratory work as a welcome relief from the monotony of asylum life. The experimental results should be compared with those in Table III. as well as with those in Table I. The only distinctly pathological feature is the tendency to reproduce an excessive number of letters.

A. R., aged 40, married; has been a labourer in the London Docks since the age of 13; in asylum one year. He gives a vivid and detailed history of his illness, in the course of which two forms of delusion appear, one regarding his unjust and cruel treatment in hospital before coming to Claybury, the other regarding a fluid which trickles through his body and gives rise to his abnormal sensations. He is in general very hypochondriac; memory for the past is apparently normal. He is intelligent, and ready for work, and is grateful for the trouble taken over him.

E. Y., aged 44, married; was first in a printing office, then served as a soldier, being in India part of the time, then kept a coffee house; his history includes alcohol and syphilis; in asylum five years; his brother died an epileptic imbecile. He is generally rather morose and dull and complains bitterly of the monotony and lack of freedom in the asylum. He expects every morning to be thrown to lions and tigers and keeps stones in his pockets so that he may choke himself should that occur; he does not now expect other people to share his belief. His memory for the past is variable, being occasionally good; memory for recent events is very imperfect. He is willing and attentive, and somewhat interested in doing the work well.

R. E., aged 40, married; well educated; was teacher before marriage; her history includes alcoholic excess; she had fits when a child and there have been recent seizures; in asylum ten months; her family is neuropathic. A short while ago she was depressed and ready to cry; she is quieter now and feels exceedingly well, but is still emotional and feeble-minded. Her memory, formerly impaired, is recovering, but she is not clear in regard to the events following the accident which precipitated her illness. There are no delusions. She is attentive and willing to do all the experiments, but is rather easily fatigued.

```
IV. V. VI. VII. VIII. IX. X. Rightly placed .. 3.8 .. 4.0 .. 4.1 .. 4.7 .. 4.9 .. 3.7 .. 3.9 (Three days, 15 expts.)
```

Table VIII.—Pathological Group II. General Results.

```
IV.
                                  v.
                                                   VII.
                                                           VIII.
                                                                     IX.
                                                                              X
(1) Rightly placed .. 3.8 .. 4.6 ..
                                          4.9 .. 5.2 .. 5.2 ..
                                                                    4.5 ..
                                          0.1 \dots 0.3 \dots 0.2 \dots 0.4 \dots
(2a) Group transposed
                        - .. - ..
(2b) Inversion
                   in)
                         0.1 \dots 0.2 \dots 0.4 \dots 0.5 \dots 0.4 \dots 0.5 \dots 0.6
  right position
(2c) Inversion
                   in)
                                          - .. 0.2 .. 0.2 .. 0.1
  wrong position
                                 - \dots 0.1 \dots 0.2 \dots 0.4 \dots 0.8 \dots 1.2
(3) Wrongly placed ...
                        0.2 \dots 0.2 \dots 0.5 \dots 0.7 \dots 1.6 \dots 2.6 \dots 3.2
(4) Omission ...
                        0.1 \dots 0.2 \dots 0.4 \dots 0.6 \dots 0.6 \dots 0.9 \dots 0.8
(5) Insertion ..
                                          0.1 \dots 0.2 \dots 0.4 \dots 0.7 \dots 0.5
(6) Repetition
(7) Defect
                                          0.1 .. 0.1 .. 0.8 .. 1.3 .. 1.9
(8) Excess
                                          0.1 \dots 0.1 \dots 0.1 \dots 0.2 \dots 0.1
                                      . .
```

Table IX.—Pathological Group II. Percentages.

```
    IV.
    V.
    VI.
    VII.
    VIII.
    IX.
    X.

    (1) Rightly placed
    ... 94·8
    ... 92·2
    ... 82·0
    ... 73·6
    ... 64·9
    ... 49·7
    ... 44·6

    (2) Partial disorder
    ... 1·5
    ... 4·0
    ... 8·5
    ... 13·7
    ... 10·8
    ... 12·0
    ... 11·3

    (3) Wrongly placed
    ... -
    ... 0·2
    ... 1·5
    ... 2·7
    ... 5·0
    ... 8·9
    ... 12·4

    (4) Omission
    ... 3·8
    ... 3·6
    ... 8·0
    ... 10·0
    ... 19·4
    ... 29·4
    ... 31·6
```

The experimental results in this group form a descending series. The first two cases are somewhat above the normal average in group A, the others fall below it, but are above the two lowest normal totals. If we look at the general averages for the whole group, we find that in many features there is a close resemblance to the results of group A, both

in the magnitude of the errors and in the form of the curves. There are differences, but they hardly pass the limits of accidental variation; perhaps the most significant fact is the increase of magnitudes in the column of excess. It is worthy of note that this last feature is shown most distinctly by the subject whose averages are highest (R. S.). We seem justified, then, in concluding that the processes involved in the act of immediate reproduction have not been changed in an appreciable degree in this group. If on this basis we treat the results as approximately normal, they may be considered as an independent confirmation of the general conclusions already established in regard to the magnitude and the variation of the several kinds of error in the normal mind. The following is the average percentage of quite correct reproductions at each stage:—

PATHOLOGICAL GROUP III.

In the last group the general features are some degree of dementia, confusion and loss of memory, and the presence of marked alcoholic habits in the previous history. The classification, though not quite satisfactory, seems preferable to the construction of smaller groups. The first three patients are women, the last two are men. All except the last subject, P. S., give absolute totals which are below that of the lowest normal subject (vide Tables V. and XII.). All except the first are between fifty and sixty years old, a circumstance which suggests that senile decay is one of the causal factors.

P. E., aged 35, married; is in early stage of general paralysis, and has alcoholic neuritis; in asylum nearly a year. She is emotional and changeable in mood. She gives a coherent story of her early life, but has forgotten her more recent history, and does not know that she is in an asylum; previous visits to the laboratory are very imperfectly remembered. Two statements are made at different times regarding her married life: (1) her husband is a soldier, who deserted her; (2) her husband, who is a

farmer, is devoted and loving, her chief trouble being the anxiety and sorrow she is causing him. During the experimental work she is usually cheerful and willing, but rather talkative and wandering. From one point of view the case belongs to the second group, but on the whole, the present grouping seems preferable.

A. M., aged 60; widow, third attack; in asylum a year. She gives a detailed history of her early life; recent events are remembered imperfectly. She is emotional and excitable, and much troubled about her future after she leaves the asylum. She is attentive and willing, but talkative during the laboratory work. The longer series are objected to as being too hard for her.

Rightly placed ..
$$3.9$$
 .. 4.8 .. 4.9 .. 4.0 .. 3.3 .. 2.3 .. 3.1 (Three days, 15 expts.)

E. S., aged 57, married; in asylum a year. She attributes her illness to the death of both parents and a brother shortly before her admission. Her recollection of past life is hazy and her statements are confused and uncertain; her memory, she says, has been poor all her life. The experiments are gone through in a dull mechanical way, but she is quite ready to do all the work. Perhaps her education has been less than that of any other subject, but it does not appear that this has influenced the results to any great degree.

Rightly placed ..
$$3.0$$
 .. 3.2 .. 2.3 .. 2.2 .. 2.1 .. 1.8 .. 1.2 (Three days, 15 expts.) 2

T. T., aged 52, married, provision merchant; in asylum two years. He is irritable and discontented, complaining bitterly of want of food, bad treatment, aches and pains. He is completely confused about recent events, asserts constantly that he came to this place a week ago, and can with safety be told each forenoon that he will be discharged in the afternoon. He believes that he is in a "truss hospital" for rest and for treatment of his rupture. Though his mood is changeable, he is usually dull and uninterested in the laboratory work. He is willing to attempt what he is asked to do, but cannot, whatever is said, understand

² This subject contributed twelve experiments at the ninth and tenth stages.

¹ This subject contributed twelve experiments at the ninth and eight experiments at the tenth stage.

what the experiments have to do with his rupture. He objects strongly to the longer series and there are no experiments to report for the tenth stage.

Rightly placed ..
$$3.5$$
 .. 3.8 .. 4.2 .. 4.3 .. 3.3 .. 1.9 (Three days, 19 expts.)

P. S., aged 53, married; painter; ten years ago had a number of fits, and has always been nervous; has persistent unilateral auditory hallucinations; in asylum less than a month. His memory regarding early life is hazy and uncertain; recent events, including visits to the laboratory, are almost completely forgotten. The work in the laboratory is done readily, but without interest. In reproducing the series he is much slower than any other reagent, and recalls the letters apparently with difficulty one after another. The case presents an interesting contrast between complete confusion and a relatively high power of immediate reproduction; the power to form permanent associations is absent, while apperception and immediate memory remain.²

Table X.—Pathological Group III. General Results.

	IV.	v.	VI.	VII.	VIII.	IX.	X.
(1) Rightly placed	3.7	4.1	4.0	3.9	3.3	2.6	2.7
(2a) Group transposed	- ·		0.1	0.4	0.3	0.2	0.4
(2b) Inversion in ; right position	0.1	0.3	0.4	0.2	0.3	0.3	0.1
(2c) Inversion in wrong position		–	0.1	0.2	0.1	0.1	0.5
(3) Wrongly placed	–	0.1	0.3	0.6	1.0	1.5	1.4
(4) Omission	0.3	0.4	1.1	1.8	3.0	4.3	4.9
(5) Insertion	0.3	0.5	0.9	1.2	1.3	1.2	1.2
(6) Repetition		0.1	0.3	0.5	0.8	0.6	0.9
(7) Defect			0.2	0.2	1.0	2.5	2.8
(8) Excess	0.1	0.2	0.2	0.2	0.1		_

¹ At the ninth stage he contributed thirteen experiments.

² Since this paper was written I have had an opportunity, through the courtesy of Dr. Baily, of examining a patient in Hanwell Asylum who shows symptoms like those of P. S. in this group. This patient is 43 years old, and was admitted suffering from marked alcoholic neuritis. She remembers events in her early life; recent years are completely forgotten; daily events make no impression. On the other hand her power of immediate memory is fairly good, the absolute total of rightly placed letters at all stages being 28.7 (three experiments at each stage). It is to be noted that here, as in the case of P. S., the patient's conversation is rational and coherent.

Table XI.—Pathological Group III. Percentages.

		IV.	v.	VI.	VII.	VIII.	IX.	х.
(1) Rightly placed	••	91.3	 $82 \cdot 2$	 66·5	 55.5	 40.8	 2 8·6	 27.0
(2) Partial disorder		2.0	 7.0	 10.0	 10.9	 8.6	 7.0	 9.6
(3) Wrongly placed		0.3	 2.4	 4.8	 8.0	 12.9	 17.1	 14.4
(4) Omission		6.3	 8.4	 18.5	 25.4	 37.8	 47.3	 49.0

The results of this group are in marked contrast with those of the normal groups and those of the second pathological group, while they are in general agreement with those of the first pathological group. The same constancy of partial disorder as is met with in the other groups is found here; the magnitude of the errors under this heading is lessened somewhat by the inclusion of the results of P. S. The following is the average of quite correct reproductions.

Table XII. contains data similar to those given in Table V.; I have included in it the data of all the pathological

TABLE XII.—Pathological Groups.

		Group I	•		Grou	p II.			G	roup II	ī.	
	J.D.	I.S.	S .S.	R.S.	A.R.	E.Y.	R.E.	P.E.	A.M.	E.S.	T.T.	P.S.
Abs. Totals	25.7	24.2	22.7	36.3	34.1	30.9	29·1	24·1	25.7	15.7	22.9	31.7
Prob. Err., VI	0.3	0.2	0.2	0.1	0.2	0.3	0.3	0.3	0.2	0.2	ზ∙2	0.2
Prob. Err., IX	0.3	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.2

groups.¹ It will be observed that the probable error in the case of the patients is very similar to that of the normal subjects. This may be taken as meaning that in the brief effort required by these experiments there was no great scope for marked fluctuations of attention. The average mean

¹ As no results could be gained from T. T. at the tenth stage, the total in his case is an approximate estimate.

variation (not given in the table) is somewhat higher with the patients at the sixth stage than with the normal subjects; at the ninth stage it is practically the same for both. Such results add to the evidence for the practicability of psychological experimentation with abnormal subjects.

There is one more case on which observations have been made by the preceding method; it differs so greatly from all those which have preceded that it must be taken by itself. The patient is aged 65, has been a teacher of history; was admitted to the asylum recently. He is in a condition of high intellectual excitement and his conversation, while perfectly coherent and rational, is remarkable for an unceasing flow of reminiscences and ideas. The patient is extremely interested in the experiments and willing to give every assistance, but owing to the extraordinary mass of ideas roused by every object and incident it is in fact exceedingly difficult to get a satisfactory number of experiments. In anticipation of an ability above the average the series of letters employed were those ranging from six to twelve letters. The results may be regarded as suggestive of variations rising above the normal attainment, which a further use of the method in cases of mental excitement may reveal. In this case the general average of the second normal group (B) supplies the appropriate means for comparison.

Owing to the fact that the experiments demanded relatively little effort and that the interval between the days on which each reagent appeared in the laboratory was, as a rule, two weeks or longer, there was little opportunity for the development of the effects of practice. I have, however, worked out the averages of rightly placed letters for each individual and for each stage on the successive days in order to determine with some precision what general changes might be expected to occur from day to day. The results are not given for each individual, but are condensed into summaries for the first normal group A, and for the three pathological groups; they are presented in Tables XIII. and

Table XIII.—Group A. Normal Individuals: Daily Averages.

	Day.	rv.	V.	VI.	VII.	VIII.	IX.	X-
Nine Subjects	First	40	4.5	4.8	4 ·9	4.7	4.8	3.9
	Second	3.9	4.8	5.1	5 ·2	5.4	4.2	4.9
Four Subjects	(First	4.0	4.4	4.4	4.6	3 ·8	4.3	3.3
	Second	3 ·9	4.8	5.0	4.8	4.6	3.9	4.1
	(Third	3.9	4.6	4.6	5 ·1	4.8	4.7	4.4

TABLE XIV.—Daily Averages.

XIV. It is to be noted that in Table XIII. the first two horizontal columns give the averages for all the nine subjects. Five of these subjects, however, gave experiments on two days only; hence, in order to get an idea of the changes, when the experiments were continued three days, I have taken the results of the remaining four subjects and determined their averages separately for first, second, and third days. If we set the increase against the decrease on each day in the different tables we find that the total changes are slight and irregular, though they point on the whole towards improvement. The somewhat more marked improvement in the third pathological group on the last day may possibly be an indication of progress towards recovery. The general improvement is probably due as much to adaptation to the environment of the laboratory as to the effects of practice. The figures are of use in another way, as affording data for

the answer to a question which is of considerable practical interest: How far must such experiments be carried in order to secure a reliable average? It seems clear that two days' work, including ten or more experiments, would give a fairly representative result if only the total of rightly placed letters is taken into account. If the analysis is to be carried as far as it has been in this paper, a larger number of experiments is undoubtedly desirable.

I have also analysed certain of the results in order to determine the distribution of errors, or in other words to find out how the different points in the series are affected by error. In Table XV.¹ is given the percentage of rightly placed letters at each point in each of the last four stages. The upper horizontal column shows the distribution of errors in the case of the four normal subjects whose results appear in the lower half of Table XIII.; the lower gives the

TABLE XV.—Distribution of Errors.

Stage VII.																			
		1		2		3		4		5 .		6		7					
Normal		96		73		70		62		50		55		79					
Pathol.		83	••	59		43	٠.	38		37	• •	42		75					
Stage VIII.																			
		1	-	2		3		4		5		6		7		8			
Normal		96		7 3		5 9		56		33		31		40	• •	65			
Pathol.		83		59	••	45		38	• •	22		16	• •	21		46			
Stage IX.																			
		1		2		3		4		5		6		7		8	 9		
Normal		90		60		54		51		45		23		17		26	 63		
Pathol.		82		43		34		22		10		16		14	• •	13	 37		
Stage X.																			
		1_		2		3		4		5		6		7		8	 9		10
Normal		94		59		46		44		3 8		17		20		20	 28		61
Pathol.		72		30		21		10		18		14		11		22	 13		38

^{&#}x27;In this table I have added the individual results together and taken a final average, instead of first working out a separate average for each subject, as in the other tables.

distribution in the first pathological group. The normal results were further analysed to find out whether there were any noteworthy peculiarities in the distribution of the different classes of error: nothing of special interest was noticed, except the fact that when an error occurs in the first place it is practically always an error of omission.

It will be observed that in every instance, normal or abnormal, the first letter is better remembered than the last, and the first half of the series better than the last half. Corresponding with this relation is the remark made by several subjects that if they lost the first letter everything disappeared. Galton, in the paper already cited, states that when series of three figures or letters were presented it was the last number of the series which was best remembered by the idiot and imbecile children. There is no trace of such a relation here, though the last place in a series is undoubtedly more advantageous than several others. It is quite possible that when the mental deficiency is very great recency of impression is a much more important factor in determining what shall be reproduced. It may be added that Galton found, when testing the nine best girls in a class of idiots, that on the average four was the greatest number of figures recollected perfectly.

EXPERIMENTS ON RECOGNITION.

Before passing on to the final consideration of the results above reported, I wish to present in the form of a preliminary communication a series of experiments designed to test memory in another of its phases. The method already described analyses only the initial stage, and some other equally simple procedure is desirable for testing other stages of the process. The memory for long past events can usually be investigated only by questions, and obviously in the great majority of cases the value of the answers cannot be submitted to an objective test. In the pathological individuals already studied the defect in memory for past events seemed generally to be greatest in regard to the beginning and subsequent course of the illness. The recol-

lection of recent occurrences which we may call recent memory, seemed capable of being investigated by the following method 1 of "recognition" or "selection":-

Small cards bearing pictures were arranged in packs, each pack containing eight cards. The pack was handed to the reagent at the beginning of the hour, with the request that he would look at the pictures; he was told that they would be shown to him again afterwards. At the end of an interval, which varied in length with the duration and nature of the intervening work and the disposition of the reagent, but was usually 30 to 45 minutes in length, two new cards were added to the pack, the cards were shuffled, and the reagent was then asked which ones he had seen before. this way opportunity was given for the operation of two processes—forgetting, and the confusion of old and new. A similar test was made with lists of words. Ten words relating to objects within the range of ordinary experience were arrayed in a series and typewritten on a slip of paper. A slip was handed to the reagent at the beginning of the hour; at the end of the interval another slip was shown with the old words arranged in a different order and four new ones added, and he was asked to pick out the ones he had read before. In these two ways the more permanent memory was tested without requiring any strain or disagreeable effort. Pictures were used as being attractive and interesting: those employed were copies of the works of great artists.2 The words, though not so interesting, were at least related to the actual experience of the reagents, and perfectly intelligible.

Owing to various circumstances the record of results is not so full as could be desired, but as they throw some light on the conclusions reached by the other method, and as the experiments were carried out with the same subjects, they may be brought forward here in summary form. In the horizontal columns of Table XVI. are given the results for the three groups from which sufficiently extensive experi-

For an account of this and other methods, v. Kennedy "On the Experi-

mental Investigation of Memory," Psychol. Rev., v.

² The cards used were those supplied by the Fireside Game Co., Cincinnatti, U.S.A.

Table XVI.—Recognition.

	Pictures			Words			
	Forgotten		Confused		Forgotten		Confused
Normal Group A	 1.2		0.2		2.8		1.8
II. Pathol. Group	 1.9		0.5		3.2		1.8
III. Pathol. Group	 4.7		0.9		7.2		1.4

ments were obtained. While the differences in the number of pictures and words which were presented forbid an exact comparison, it seems clear that the word test was much more difficult for all the groups than the picture test. It is in forgetting that the differences of the groups are greatest. There are indications that by this method cases such as those of E. Y. (Group II.) and P. S. (Group III.) could be differentiated from others. The method, as compared with that of immediate memory, has its disadvantages; there is more difficulty in securing uniformity in the experimental conditions, but it is easily applied; it imposes no strain on the subjects, and it seems capable of development in various directions.

GENERAL CONCLUSIONS.

It seems justifiable to conclude, on the basis of the various data which have been presented, that the method of testing mental capacity which has been used in the main part of the investigation is trustworthy, and is capable of giving valuable indications in regard to the character and progress of mental deficiency. That ability in immediate memory is in general an index of mental capacity is proved not merely by a comparison of the two normal groups, A and B, and of these with the pathological groups, but also by reference to the results of other investigations already mentioned. Jacobs, Bolton and Bourdon found, in dealing with school children, that the place assigned to a child in the class-room corresponded generally with the place given by the memory test, though the results found by Bolton were less decisive than those of the other investigators. Rieger and Galton, as we have seen, found that the method in a simpler form gave significant results

with pathological individuals. On the ground of this consensus of results it seems fair to correlate the ability which we have been analysing with intellectual capacity. We may perhaps also bring it into relation with the ability which is so serviceable in life of taking a broad view of a subject, of keeping in mind the various factors of a complex problem or argument.

What the limitations of this method are as applied to mental disease can only be determined with precision by its extensive employment in different forms of insanity. So far as the results go which have been obtained in the different cases, the pathological changes are similar in character. We seem to have the same kinds and degrees of error whether we are dealing with general paralysis or with the mental deficiency due to alcohol or other causes. There are no marked differences which would enable us to distinguish one mode of associational and reproductive failure from another. On the other hand the method appears to give us a means of studying certain definite processes and changes which may enter, in varying degree, into different forms of mental disease. It is not possible to bring these phenomena into close relation with any of the general forms of mental defect currently recognised by alienism. The state of dementia, as the term is commonly used, refers not to any limited and clearly defined group of processes, but to the general weakening of the mental life in its more intellectual relations. If we were to attempt to estimate with scientific precision the nature of the changes which occur when the mind is enfeebled, we should require not merely the analysis of one group of processes, such as has been given in this paper, but an extensive and varied series of tests dealing with each aspect of our ideational and intellectual life. The changes in immediate memory constitute probably an important element in the process of mental dissolution, but without doubt they form only part of a complex set of changes. If we keep this point in view we can understand how a normal individual can show an exceedingly poor result when this test is used. If only one factor in mental life is weakened, or below the average,

while the others retain their normal efficiency, we have probably an instance of compensatory interaction, whereby other factors take on additional work and so by their united action enable the individual to discharge the ordinary duties of life.

There are two further points which deserve mention. I have already pointed out that the character of the probable error forbids the supposition that in the pathological groups we have to do with any abnormal fluctuations of attention. The observations which have been made on the behaviour of the patients are decidedly in favour of the assumption that the lessened values in the pathological groups are not due primarily or chiefly to lack of attention, but are caused by differences in mental range in the power of immediately forming a group of associated ideas. This view finds additional support in the observations of Wernicke in regard to the relations between attention and Merkfühigkeit.

The other point concerns the different forms of memory which have appeared in the course of the investigation. The immediate memory may be poor while the general memory is approximately normal. An instance of this is to be found in the patient J. D., Group I. Again, the immediate memory may be approximately normal while there is great confusion in regard to recent events. We have already noted this peculiarity in the case of P. S., Group III.; a somewhat less clear example is to be found in E. Y., Group II.

Lastly, we may have interference both with immediate memory and with the recollection of recent and somewhat remote events. Examples of this type are to be found in P. E. and T. T., Group III. When we look at the data in this way we notice the interesting fact that by means of psycho-pathological evidence we are able to draw a distinct line between immediate memory and the more permanent memory. We seem justified also in concluding that there

² Cf. Observations by Kraepelin, loc. cit., and by Rieger, Zur kennt. d. progr. Par.

Loc. cit. s. 76. "Wir werden deshalb in der Merkfähigkeit ein Prüfungsmittel für die Thätigkeit des Bewusstseinsorgans erblicken, welches auf einer selbständigen and nur bedingungsweise von der Aufmerksamkeit abhängenden Eigenschaft der in Betracht kommenden nervösen Elemente beruht."

are relatively distinct metabolic processes underlying the two activities. At least it seems clear that pathological processes, while they affect one need not affect the other, though they may do so.

GENERAL SUMMARY.

- (1) The method of immediate oral reproduction of auditory impressions appears to be reliable and practicable both with normal and abnormal individuals, and to be well fitted to test the range and character of immediate association in different mental states.
- (2) With normal subjects the range of immediate memory has usually a definite limit which varies with each individual, but as a rule is found to lie at five letters. When the limit is reached, the addition of one letter to the series of auditory impressions produces a very decided fall in the number of series which are reproduced quite correctly; this fall amounts to 40-50 per cent. on the average. With abnormal subjects the relations are similar but less clear.
- (3) In the abnormal cases which have been studied the general nature of the pathological changes is similar. They consist in a marked diminution in the power of reproducing impressions in correct order, and in a more or less distinct increase of all the errors indicating the more severe forms of associational disorder.
- (4) In all the groups, normal and abnormal, within certain limits the total of errors indicating partial dissociation or disorder remains relatively constant and reaches approximately the same absolute magnitude.
- (5) None of the groups shows any marked fluctuations of attention, or any distinct and regular improvement by practice.
- (6) With the help of this method we are able to differentiate with some precision between the more permanent memory and the power of immediate reproduction.

In conclusion, I desire to express my hearty thanks to Dr. F. W. Mott, Director of the Claybury Laboratory, for his constant assistance and for the exceptional facilities which I have enjoyed in carrying on this research. Dr. J. S. Bolton, assistant to the Director, has generously given his help by acting as a subject during the experiments, and in many other ways. I am under deep obligations to Dr. Robert Jones, Medical Superintendent of Claybury Asylum, who has put the resources of the Asylum at my disposal, as well as to Dr. Ewart, Senior Medical Officer in the Asylum, and to the late Dr. Macmillan.

PATHOLOGICAL CHANGES IN THE MEDULLA OBLONGATA IN ACUTE DIPHTHERITIC TOXÆMIA.

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THE present paper is based upon the systematic examination of a series of thirteen cases which have died during the acute toxic stage of diphtheria; eleven of these died of progressive heart failure, due to the severity of the toxemia, and two of asphyxia, due to involvement of the respiratory passages, the latter being chosen for purposes of comparison, as in these the toxemia was less severe.

A very large amount of literature has been written on various changes occurring in the central nervous system generally in diphtheria, but no very definite conclusions have been arrived at, as observers have differed considerably in the results obtained; this, I think, is largely due to the fact that many cases have been examined without due regard being paid to the clinical aspect of the disease, as to what particular symptoms the patient presented, and at what stage of the disease death occurred.

Working on this principle, I have endeavoured to trace the exact pathology of progressive heart failure in the acute stage of diphtheria; and in each of my cases I have examined the whole medulla oblongata, and also the vagus nerve and heart, because, although the changes taking place in the latter are well known (1), for a complete investigation the whole neuro-muscular apparatus, central cell, peripheral nerve, and attached muscle, should be examined together.

All the cases have been carefully chosen so as to be of exactly the same type, and the clinical records of the cases will be *combined* with the pathological results obtained.

A brief outline of cardiac failure in acute diphtheria will first be given, after which the central connections of the vagus nerve will be referred to; the method of investigation will then be noted, and finally the results obtained will be described and discussed.

CARDIAC FAILURE IN ACUTE DIPHTHERIA.

Diphtheria is an acute specific disease in which the system is poisoned by certain toxins; it runs an acute course like other diseases of a similar character, and is followed by a period of convalescence, during which certain complications (notably paralysis) may occur as a result of the toxemia; the paralysis may sometimes come on before the acute stage is ended.

The duration of the acute toxic stage is not very clearly defined: in some cases the toxic symptoms are very slight, and this stage may be said to end almost as soon as the fauces are clean; in others they are more severe, and, although the fauces have been clean for a few days, the patient may still die from the acute poisoning.

The general statements may be made that death from acute diphtheritic toxemia almost invariably occurs within the first fortnight of the disease; that the cause of death in these cases is invariably primary failure of the heart, excluding of course deaths from an accidental cause, as asphyxia or lung disease, owing to involvement of the larynx; and that it is essentially the severe faucial cases in which death from the acute toxemia is seen.

It thus appears that acute diphtheria kills through the heart, and this is essentially the class of case with which the present investigation is concerned.

A patient dying of acute diphtheria forms a characteristic clinical picture.

Some time during the first fortnight the pulse becomes irregular and compressible, and grows progressively weaker and more irregular until it is imperceptible; the extremities become cold, the face is extremely pale and waxy-looking, and the patient is restless, but perfectly conscious; there

may be vomiting, and in some cases the urine becomes more or less suppressed, in a few cases completely so. Death occurs suddenly if any strain is thrown upon the heart, or the patient may linger for several hours or days. The pulse is on the whole rapid, but towards the approach of death it may become remarkably slow; a marked slowing of the pulse in a case of this description is an extremely fatal sign. If the toxemia is so severe as to give rise to subcutaneous hemorrhages or hemorrhage from the mucous membranes, the patient apparently invariably dies of progressive heart failure in the acute stage of the disease.

As an example I will quote the following case:-

V. P., female, aged 5; admitted to University College Hospital on March 17, 1901.

The illness commenced on March 11 with headache, a sore throat being first noticed on March 15. On admission the tonsils, uvula, and part of the soft palate were covered with blackened membrane; the breath had the characteristic odour of diphtheria; the cervical glands were enlarged on each side, and there was periadenitis; and there was a little rhinorrhoea. The face was very pale, the lips were a little cyanosed, and there were subcutaneous hæmorrhages on the trunk and limbs; the patient was prostrate, but perfectly conscious. The pulse was very irregular in force and rhythm, 128 in frequency, and at times almost imperceptible. The cardiac impulse was a little diffuse, but not obviously displaced, the sounds were feeble and corresponded with the pulse, and there were no murmurs. The lungs were normal, and there were no symptoms of involvement of the larynx. The knee-jerks were present, and there were no signs whatever of paralysis. The urine contained a thick cloud of albumen. Temperature 103°. Antitoxin 9,000 units administered.

The pulse became progressively weaker, and at noon on the following day was quite imperceptible, and the extremities were cold; the patient was somewhat restless, and died at 4.30 p.m. (Eighth day of disease). There was never any vomiting, and 7 ozs. urine were passed between admission and death. On the last occasion when the pulse could be counted it was 116 in frequency.

In less severe cases of acute toxemia in which the patient recovers, a very large proportion of cases develop

an irregular pulse with or without the signs of cardiac dilatation.

In the following case there was an irregular pulse, with signs of dilatation of the heart.

L. V., female, aged 9; admitted to University College Hospital on October 11, 1901. The illness commenced on October 6, and on admission there was well-defined membrane on the left tonsil, the rest of the fauces being swollen and injected; the cervical glands were a little enlarged; there was no rhinorrhœa. There were no hæmorrhages in the skin or from the mucous membranes. The pulse was 116 in frequency and quite regular. The cardiac impulse was in the fourth left intercostal space internal to the nipple and normal in character; the heart sounds were normal and no murmurs were present. The knee-jerks were present and there were no signs of paralysis. Temperature 102.6°. No albumen in the urine. Antitoxin 8,000 units injected on admission. On October 13 the throat was clean and the pulse quite regular in the morning, but towards evening it began to be irregular in force and rhythm and the irregularity continued until October 31. During this time the pulse varied considerably, sometimes, especially in the morning, being perfectly regular, and for the last three or four days it was only irregular for about two hours in the evening. Three days after the pulse became irregular (October 16) the cardiac impulse was in the nipple line, and on October 25 it was considerably outside the nipple, a systolic apical murmur being present; on October 29 the murmur had disappeared, and on November 8 the cardiac impulse was again in the nipple line.

During the period of irregularity the pulse was sometimes slow, the frequency varying between 52 and 88; after October 31, when it became quite regular, the rapidity increased, the lowest record being 88 and the highest 120 and the average 96 to 104.

The urine never contained any albumen.

When the heart fails during convalescence, the failure is generally associated with paralysis, or is the result of some extra strain which has been thrown upon the heart, as, for instance, vomiting, getting up too early, or undue excitement. This is the explanation of the many sudden deaths which have been recorded in diphtheria.

Heart failure at this period of the disease is much less fatal than when it occurs in the acute stage.

Thrombosis of the heart is a rare cause of death from heart failure in diphtheria, and in these cases a secondary infection by other organisms is probable.

The following case is illustrative of heart failure, resulting from strain.

S. W., female, aged 12; admitted to University College Hospital on October 9, 1900. The onset of the disease was October 6, and on admission both tonsils, uvula, and part of the soft palate were covered with membrane. The pulse was quite regular, the heart and urine normal. Temperature 99.8°. Antitoxin, 8,000 units administered. On October 16 the fauces were quite clean, the pulse was perfectly regular, and there were no signs in the heart. On October 22 the patient was allowed to sit up in blankets in a chair; four days later the pulse was found irregular, and between 90 and 100 in frequency, the cardiac impulse was displaced half an inch outside the nipple line, and was slapping in character; a systolic murmur was present at the apex, and the pulmonary second sound was markedly accentuated; the patient complained of pain and weakness in the legs; the knee-jerks were present. She was put to bed, and a nasal voice developed a fortnight later. On December 8 the pulse was between 72 and 90, and quite regular, the murmur had disappeared, and the cardiac impulse was in the nipple line; knee-jerks absent. On December 15 the patient got up again, and could walk, but had marked ataxy of the legs: no other sign of nervous affection was present. On January 6 the patient walked without ataxy, and the heart and pulse were quite normal.

THE CENTRAL CONNECTIONS OF THE PNEUMOGASTRIC NERVE IN THE MEDULLA.

Only those anatomical features which are necessary for a clear understanding of the pathological appearances detailed in this paper will be referred to, and the description, for reasons of space, is as brief as is consistent with clearness.

The vagus is a mixed motor and sensory nerve; the sensory nerve-roots represent the nerve-fibres from the cells of the jugular and petrosal ganglia.

Motor Nucleus of Vagus: Nucleus Ambiguus.

The nucleus ambiguus is the motor nucleus of the glossopharyngeal, the vagus, and the accessory portion of the spinal accessory nerve.

It is situated in the upper part of the medulla oblongata, and extends longitudinally from almost the upper extremity of the inferior olive to a point opposite the spot where the central canal of the spinal cord opens out into the fourth ventricle: it thus corresponds with the inferior olive in longitudinal extent, but reaches somewhat short of it at either end.

In transverse section (fig. 1), p. 812, it is seen in the lateral and posterior portion of the formatio reticularis, about half-way between the raphé and the side of the medulla, and deep beneath the floor of the fourth ventricle.

It is composed of groups of scattered cells, which, as a whole, form a fairly consecutive column; many single cells lie in its neighbourhood, and a considerable number lie wedged in an antero-lateral position to the main column amongst the issuing fibres of the vagus nerve: a careful study of these cells makes it almost certain that their axones directly join the issuing vagus fibres, in spite of the generally accepted, and frequently repeated, statement that all the axones pass dorsalwards and inwards, and then recurve to join the vagus root.

At its commencement the nucleus begins as a few scattered cells, which only after several ascending sections have been examined can be recognised as a distinct column. As it passes brainwards the main column has a direction tending somewhat outwards, but scattered cells still lie internal to this main column: when the upper region of the inferior olive is reached these latter cells pass without break into the large nucleus centralis inferior of the substantia grisea: in this region they occupy the exact position figured as nucleus ambiguus by Roller (2). All the cells which have been referred to are large multipolar stichochromes (Plate I., fig. 1), but the outer column consistently contains cells which, as a whole, are somewhat smaller and more

slender than the remainder, though all gradations exist, and it would not be possible on examining an individual cell to determine to which part of the mass of cells it belonged. As will be shown later, in acute cardiac failure of diphtheritic



Fig. 1.

Tracing from photograph of transverse section of medulla (Case 7) above centre of olive. The left half of the section is shown; the right hand edge of figure corresponds with the raphé, and the convoluted outline of the olive is seen in lower third of the photograph. Just above the centre of the photograph is a group of cells representing the nucleus ambiguus. A ring has been drawn round one cell, a micro-photograph of which is shown in Plate I., fig 2, and to the left of this cell a triangle has been drawn round four cells, a micro-photograph of the right-hand three of which is shown in Plate I., fig. 1. All the cells in the neighbourhood of the latter are quite normal; but surrounding the ringed cell is a group of acutely degenerated cells.

origin the larger and more internal cells are much more affected than the slightly smaller cells of the outer column; and this is particularly evident where the inner cells pass into the nucleus centralis inferior. This region, in spite

PATHOLOGICAL CHANGES IN THE MEDULLA OBLONGATA 813

of the large size, and presumably stable structure, of the cells, presents a definite localised and gross degeneration, which is common to all the cases of acute cardiac failure which have been investigated.

In one of the cases horizontal sections instead of transverse were prepared, and the appearances found exactly coincide with those described from examination of the vertical series.

It is thus by no means improbable that the region of acute degeneration to be referred to is the portion of the nucleus from which the efferent cardiac fibres of the vagus originate.

A justifiable criticism of this suggestion would be that the vagus is an inhibitory nerve of the heart, but in view of the recent investigations of Professor Onimus of Monaco (3), which, if confirmed, prove that the vagus is a true motor nerve of the cardiac muscle, it is probable that the view here expressed is in accord with experimental physiology.

Sensory Nuclei of Vagus.

There are two sensory end nuclei:

- (1) The first is situated dorso-lateral to the hypoglossal nucleus, and produces the elevation in the floor of the fourth ventricle known as the trigonum vagi. The cells composing this are small and somewhat club-shaped, with only a little protoplasm and small Nissl granules.
- (2) The second is known as the fasciculus solitarius, or descending root of the vagus and glossopharyngeal.

It consists of bundles of nerve-fibres with deposits of gray matter, the nerve-cells being small and angular, or spindle-shaped. It is situated external to the root of the vagus and ventro-lateral to the former sensory nucleus; it extends upwards as far as the upper end of the inferior olive and downwards into the cervical region of the spinal cord. Some of the entering fibres of the vagus pass down this root in a spinal direction, and owing to the constant size of the bundle it is probable that the majority of the fibres pass down for a considerable distance, giving during their course collaterals to the gray matter of the column. Neither of

these nuclei require further description, as the pathological appearances found are slight and scattered, and occur equally in all the cases examined and in almost all parts of the medulla.

METHOD OF INVESTIGATION.

The specimens were taken as soon after death as possible, and in two cases the *post-mortem* was held within two hours and two and a half hours respectively, so as to absolutely obviate *post-mortem* changes.

Medulla.—This was divided into four or five blocks, and hardened in formalin (10 per cent). Each block was embedded in paraffin, and cut from end to end into sections by means of a Cambridge rocking microtome.

Duplicate twentieth sections were selected from the ribbons so obtained, mounted on cover slips, and one series stained by Nissl's method. In this way an ascending series of sections through the whole medulla was obtained.

In two cases the second series was mordanted in a three-quarter saturated solution of potash iron-alum, stained in a 1 per cent. solution of hæmatoxylin containing a little absolute alcohol for preservative purposes, differentiated in 1 per cent. nitric acid, and blued in tap water. This series gave a distinct view of the course of the nerve-fibres, and showed clearly all the coarser changes in the nerve-cells, although by this method the Nissl granules were, as a rule, not so beautifully defined as by the Nissl method.

Examination of this series confirmed the results obtained from the former series. The advantage of this method is its permanence (4).

The second series of another case was mordanted in 2 per cent. ammonium molybdate in an incubator, stained for some days in the incubator in Kultschitzky's hæmatoxylin, and differentiated by the Pal method, potassium permanganate of a quarter the usual strength being employed, and the differentiation being carried out by frequently alternating the baths.

In spite of the fact that these sections had not been hardened in a chrome solution, the whole of the fibres of the medulla were beautifully stained, the cells also showing the same appearances as in the other series (5).

These different methods were used as controls of the Nissl method, and in order that the fibres of the medulla might be at the same time examined. This is not usually considered possible with sections stained by the Nissl method.

Vagus.—This was hardened in Müller's fluid, stained in Marchi's solution, cut in celloidin in the usual manner, and mounted in balsam.

Other portions of the nerve were teased and mounted in Farrant's solution.

Ganglion of trunk and root of vagus.—These were in three cases treated in the same way as the medulla, and stained by Nissl's method.

Heart.—Portions of the heart wall, including the papillary muscles and pericardium, were hardened in Müller's fluid, stained in Marchi's solution, and cut in celloidin. In addition the two cases which showed no fat were stained in hæmatoxylin.

Owing to the somewhat laborious nature of the investigation, the numerous other well-known methods of staining which are usually employed were not made use of, the choice being restricted to those of direct practical value.

DESCRIPTION OF CASES EXAMINED.

As various acute changes in nerve-cells have been described as the result of the action of different poisonous substances, I shall first give a brief summary of the changes that I have observed to occur in the large motor cells of the medulla, which have undergone acute degeneration in my cases. After this the first case will be described in some detail, and the subsequent cases at shorter length, the points of agreement or difference being laid stress upon.

Acute Degenerative Changes.

Both slight and gross changes can be seen in the same slide, and therefore the probable course of events can be made out with tolerable accuracy. The slighter changes affect the Nissl granules of the cell, and, owing to the very large size and definite outline of the granules in the particular cells under consideration, the changes are, in the majority of cases, very evident.

The change apparently commences round the nucleus of the cell; the granules seem to break up or to be dissolved, and their place is taken by a more or less finely granular débris (chromatolysis). This process spreads in every direction throughout the cell, and finally affects the dendrites, because later stages are seen in which the whole cell is finely granular, and has only a single layer of Nissl-bodies arranged round the periphery. At this period the nucleus looks swollen, and is usually eccentric. I may here add that I have not made use of any cell for observation in which I could not see the nucleus, in order to obviate the error of regarding a cell as abnormal when it might have been cut in two by the razor and the nucleus retained in the adjoining section.

The gross changes, which are probably later stages of the same process, consist of a uniform swelling of the whole cell, and a further change in the position of the nucleus, which now appears at one side of the cell and frequently causes a local bulging of its wall, as if it were about to be extruded. A swollen cell contrasts markedly with a normal one, especially if they happen to be lying side by side, as is frequently the case in my sections; instead of the normal concave, bold outlines of the cell, there is seen a large globular body with convex borders, and having the appearance of being blown out. Further changes than this I have not, as a rule, observed (see Plate I., figs. 2 and 3).

Case 1.

Clinical record.—L. F., female, aged 8; admitted to University College Hospital on September 12, 1901. Onset of disease September 7. On admission the tonsils, uvula, and faucial pillars were covered with thick discoloured membrane, there was profuse rhinorrhæa with excoriation of the nostrils, and the cervical glands were enlarged on each side; tongue thickly furred

and breath foul. The face was very pale and there was a subcutaneous hæmorrhage on the right leg. Pulse weak but regular and the heart quite normal. Temperature 101.6°. Antitoxin 8,000 units administered.

September 13.—A fresh hæmorrhage on the left shoulder and bleeding from vagina; pulse 120 and a trifle irregular in both force and rhythm; cardiac impulse in the fifth left intercostal space internal to the nipple; no urine passed since admission; left tonsil clearing; in the evening there was epistaxis.

September 14.—Pulse 144, irregular; cardiac impulse can be felt in the nipple line and is slapping in character. Since admission 15 oz. urine have been passed.

September 15.—Pulse 108 and rather more regular but very weak; fresh bæmorrhages on the right forearm and the left side of the face.

September 17.—To-day patient vomited and now the cardiac impulse is half an inch outside the nipple line; no murmurs; pulse 120, irregular; a fresh hæmorrhage on the left thigh, and vaginal bleeding continues; left tonsil and uvula now quite free from membrane; no urine passed for twenty-four hours.

September 18.—Pulse much weaker and more irregular; on the whole the rate is slower, varying from 78 to 104, and on examining the pulse every hour its irregularity is found to vary considerably during the day, the pulse sometimes being almost regular and soon after becoming extremely irregular. Heart as before. The extremities are cold and the face is extremely pale, but the child is quite conscious and bright; 7 oz. urine were passed during the night; the patient has vomited twice.

September 19.—This morning patient asked for a little jelly and a short time after taking it vomited considerably; the pulse then suddenly became imperceptible, the face livid and the pupils dilated; the heart could not be heard and after a few gasps at intervals the patient was quite dead (thirteenth day of disease). A very noticeable feature in this case is the effect of vomiting on a progressively failing heart.

On September 17, when the vomiting commenced, the heart's impulse passed half an inch outside the nipple line, and on September 19 the strain of vomiting caused sudden and fatal syncope. At the autopsy which was conducted two hours after death (in order to secure the medulla before post-mortem changes set in) the stomach was found to be distended with gas, and the air passages were quite normal and free from any foreign substance.

Pathological Appearances.

Medulla.—For greater clearness and in order to save space, the individual sections will be described in tabular form (see p. 819), the salient features of each being noted. It will be seen that there are a few scattered acute degenerative changes in most of the nuclei composed of small cells, the dorsal sensory nucleus suffering more than the sensory nucleus of the vagus, although at the upper part of the latter there are some fairly well-marked degenerative changes in the cells; these smaller cells will not be referred to again, as there is no definitely localised lesion in any of the groups.

Of the large multipolar stichochrome cells, which are presumably more resistant to the action of toxins than the smaller variety, those of the hypoglossal nucleus are perfectly normal in every section; those of the seventh nucleus are also quite normal, the seventh nucleus forming as it were a continuation upwards of the nucleus ambiguus. The nucleus ambiguus, together with the nucleus centralis inferior, are the only groups of multipolar cells affected, and here a definitely localised lesion occurs.

The degeneration commences at the beginning of block iv., which corresponds to a point rather lower than midway between the apex of the calamus scriptorius and the striæ acousticæ. The degenerative changes are slighter here than at the upper portion of the nucleus and are scattered, a few degenerated cells lying amongst cells which are as a whole quite normal. Higher up at about the centre of the block, the changes become most marked in the inner group, and are still scattered; after about fifty more sections have been passed, the cells of the inner group are as a whole degenerated, only a few normal ones being intermingled; and towards the end of the block practically all the cells are very grossly degenerated, being extremely swollen out with the nucleus touching the cell wall, or causing it to protrude, and without a trace of Nissl-bodies. All stages of degeneration can be here made out from one or two perfectly normal cells to the most grossly degenerated cells, the latter greatly predominating in both number of cells and extent of degenerative change. The outer group of rather smaller cells can be seen immediately outside these degenerated cells, and appears to form a more or less normal column, with one or two scattered degenerated cells in some of the sections; this outer column forms a strong contrast with the inner degenerated group, its cells having bold concave borders and large well-defined Nissl-bodies. The sections at the beginning of block v. show similar changes, and the greater portion of the nucleus centralis inferior appears to be degenerated. At a higher level the cells become

	Hypoglossal	Nucleus Am	Nucleus Ambiguus (Large Multipolar).		
	Nucleus. (Large Multipolar.)	Inner Group and Nucleus Centralis Inferior.	Outer Groups and Cells in Fibres of X. and IX.	Sensory Nucleus X. and IX. (Small cells.)	Other groups of cells. (Small cells.)
Block III. Section 1	Normal.	No cells visible.	No cells visible.	Normal.	Normal.
,, 2 to 8			One or two scattered cells, quite normal. No cells visible.	2 4	A few slightly degenerated cells.
" 10 "	2 2		One cell on left side, quite normal. A definite group on each side, quite normal.	A few scattered cells showing degenerative changes.	Practically normal. A few scattered degenerative changes, especially in dorsal sensory nucleus.
Block IV. Section 1	:		2	Normal.	A few scattered degen- erated cells.
: ©1	£	r r	A few acutely degenerated cells mixed with normal ones; some lying in the course of the nerve.	Practically normal.	
" 3 ·	2 2	,, ,,	Normal. A few degenerated cells in the group.	A few slightly de- generated cells.	33 33
,, 7 and 8	: :		Practically normal. One or two degenerated cells in the		***
11	£ \$	A few cells have appeared; these are normal and	normal groups. Practically normal. Normal, except one cell on the left side which is acutely degenerated.		
,, 18 and 14	:	degenerated cells mixed. Degenerated and normal	One or two slightly degenerated cells.		
" 15 to 17	•	Practically all grossly de-	Normal.	Practically normal.	
,, 18 and 19		generation very gross in almost all the cells.	Normal (very few cells).	A few grossly de- generated cells.	Degenerated cells chiefly in the dorsal sensory nucleus and raphé.
Section 1 to 3	Only one or	A few normal cells; others	Normal.	A few degenerated cells.	A few scattered cells de- generated.
,, 5 and 6	No cells visible.	Cells much more normal. Normal and degenerated	Mixed normal and degenerated cells;	" "	
,, 7 to 9	: :	Only one group of cells, where cells in the group	Only one group of cells, which are mixed normal and degenerated. Fewer cells in the group and they are practically normal.	Practically normal. No cells.	Practically normal, Normal,

more normal, and finally the seventh nucleus and gray matter of the pons appear, both of which are quite normal.

Vagus nerve.—No degeneration whatever can be made out.

Ganglia of vagus.—These sections show excellent specimens of perfectly normal ganglion cells.

Heart.—The degeneration affects both auricles and ventricles, and the ventricle is apparently most affected, especially at its apex. The degenerative changes consist of marked fatty degeneration of certain muscular fibres. There is apparently a certain amount of selective action on the part of the diphtheritic toxin, as fibres showing extreme fatty degeneration, in some cases being almost completely converted into granular and fatty débris. are found lying next to fibres which are perfectly normal. The stages passed through appear to consist of a slight swelling of the fibre and cloudy appearance; it becomes granular, and finally small drops of fat appear in its substance, and in the more advanced cases these drops appear to run together, forming large drops, and the fibres thus appear to become disintegrated. It has appeared to me that a loss of striation in the fibre is not always an early change, as I have frequently seen markedly fatty fibres showing well-marked striation. All these stages are quite apparent in the same section, and are mixed together and with perfectly normal fibres at random. The most advanced fatty changes are especially noticeable in the papillary muscles and beneath the endocardium: the fatty change is less marked in the middle layers of the wall of the ventricle and under the pericardium, the muscular tissue being in these situations, as a whole, fairly normal. Towards the apex of the ventricle the fatty degeneration appears to extend outwards, more of the thickness of the wall being involved. The interstitial tissue appears quite normal; there are no hæmorrhages, and the capillaries are not unduly dilated with blood; no degenerated nerve-fibres have been found; and there is no degeneration in the walls of the small blood-vessels. Plate I., fig. 4.)

Case 2.

Clinical record.—M. E. B., female, aged 5 years and 9 months; admitted to University College Hospital on September 23, 1901; the onset of the disease was September 17. On admission the tonsils, uvula, soft palate, and part of the pharynx were covered with thick, dark-yellowish membrane, there was blood-stained rhinorrhæa and fætid breath, and the cervical glands were enlarged on both sides. No subcutaneous hæmorrhages. The cardiac

impulse was diffuse, but did not extend beyond the nipple line, and the pulse was 106 in frequency, extremely irregular in force and rhythm, and very weak. No vomiting. Temperature 100.4°: no urine passed. Antitoxin 6,000 units administered.

The pulse became gradually imperceptible, and the patient died the same evening (seventh day of the disease).

Pathological Appearances.

Medulla.—The changes are practically identical with those in Case 1. The inner group of cells of the nucleus ambiguus is grossly degenerated, and at one spot quite near the upper end the outer group is also grossly degenerated.

Vagus.—Normal.

Ganglia of vagus.—Normal.

Heart.—Fatty degeneration of muscular fibres intermingled with perfectly normal fibres, and with fibres showing the earlier changes described in Case 1. Near the apex of the ventricle the fatty change is very extensive.

Case 3.

Clinical record.—L. D., female, aged 3; admitted to University College Hospital on June 27, 1901. The onset of the disease was June 24, and on admission both tonsils and faucial pillars were covered with thick membrane, the breath was foul, and the cervical glands were enlarged on both sides; there was a little rhinorrhæa with epistaxis, and several subcutaneous hæmorrhages. The pulse was regular and 120 in frequency. Temperature 101°. Antitoxin, 6,000 units administered. On the following day the pulse began to be irregular.

June 29.—Pulse very irregular and weaker. Hæmorrhage from the bowel and several fresh subcutaneous hæmorrhages; 12 oz. of urine passed in twenty-four hours.

June 30.—Almost pulseless at 5 a.m., but the pulse was much stronger and more regular in the afternoon, and at 11 p.m. its frequency sank to 60.

July 1.—At 7 a.m. pulse was 58; it gradually became weaker, and death occurred in the afternoon. There was never any vomiting, and in the last twenty-four hours 5 oz. of urine were passed.

Death occurred on the eighth day of the disease.

Pathological Appearances.

Medulla.—There is a marked patch of degeneration in the nucleus ambiguus as described in the previous cases, and the changes here are very gross; the degeneration in the groups of small cells is scattered.

The hypoglossal nucleus and the seventh nucleus are normal. Vagus nerve.—Normal.

Ganglia of vagus.—Not obtained.

Heart.—Fatty degeneration throughout most of the wall, best marked in the papillary muscles and becoming progressively less marked towards the pericardium, under which the muscular fibres are relatively normal.

The degenerative changes are exactly the same as in the previous cases (see Plate I., fig. 4).

Case 4.

Clinical record.—V. P., female, aged 5; admitted to University College Hospital on March 17, 1901, and died on the following day (eighth day of the disease).

For clinical record, refer to page 808, where the case has already been described.

Pathological Appearances.

Medulla.—The definite degenerated area in the nucleus ambiguus described in Case 1, is in this case very well marked, and there are many more cells in the outer groups affected than in that case; the degeneration in the latter group also extends much lower, and the changes at this level are more gross.

The hypoglossal nucleus contrasts markedly with the nucleus ambiguus, the cells of the latter being grossly degenerated, whilst those of the former seen in the same section are quite normal.

The remaining groups of cells show scattered degenerative changes.

Vagus.—Normal.

Heart.—Fatty degeneration and cloudy swelling occurs as described above.

The capillaries in the interstitial tissue are much dilated and distended with blood, the smaller arteries and veins showing a similar appearance; there are a few hæmorrhages into the muscular tissue of the ventricle.

Case 5.

Clinical record.—J. F., male, aged 2½; admitted to University College Hospital on May 29, 1901. The onset of the disease was May 24. On admission the whole of the fauces and soft palate were covered with blackened foul-smelling membrane, and there

was profuse discharge from the nose, with some epistaxis; there was slight stridor, but no retraction of the chest or other symptoms of laryngeal involvement. The face was waxy and expressionless, the hands cold, and the pulse barely perceptible. The cervical glands were enlarged on each side. Temperature 101°. There was occasional vomiting, and a few subcutaneous hæmorrhages were present. No urine was passed before death, which occurred at 6 p.m. on the same evening (sixth day of disease). Antitoxin, 6,000 units were administered on admission.

Pathological Appearances.

Medulla.—On the whole the appearances are practically identical with those described under Case 1, the patch of degeneration in the nucleus ambiguus occurring in the same situation.

Vagus.—Normal, and no degeneration was found in the fasciculus solitarius.

Ganglia of vagus.—The ganglion of the trunk of the vagus appears to be composed chiefly of large ganglion cells, and the ganglion of the root entirely of much smaller cells. There are slight and scattered degenerative changes in each ganglion, and an impression seems to be gained that the majority of the large cells are normal, the degenerated cells being chiefly of the smaller variety. A few of the large cells, however, are certainly in a condition of acute degeneration.

Heart.—Fatty degeneration and other earlier changes as described above.

There are hæmorrhages into the muscular substance and also into the papillary muscles just under the endocardium.

Case 6.

Clinical record.—W. J. K., male, aged 10; a patient in the Homerton Fever Hospital, suffering from severe faucial diphtheria. The onset of the disease was April 10, 1901. The heart began to fail April 17, the pulse being irregular and 120 in frequency; there was vomiting on April 18 and 19. On the average 12 oz. of urine were passed per diem, and it contained a little albumen. Death occurred from progressive heart failure on April 20 (eleventh day of the disease).

Pathological Appearances.

Medulla.—In the same condition as Case 1, many of the nucleus ambiguus cells of the inner group being extremely degenerated (Plate I., fig. 3).

Vagus.—Not obtained.

Heart.—Fatty degeneration extremely marked, even more than in Case 1; several hæmorrhages into the muscular substance of the heart wall.

Case 7.

Clinical record.—E. M., female, aged $3\frac{1}{2}$; a patient in the Homerton Fever Hospital, suffering from severe faucial, nasal, and laryngeal diphtheria. There was broncho-pneumonia, and on admission tracheotomy was performed. The onset of the disease was April 18, 1901. The heart began to fail on the evening of April 20; there was no vomiting or suppression of urine, which contained a cloud of albumen. A few subcutaneous hæmorrhages appeared on April 21, on which date the patient died of heart failure, no doubt accelerated by the broncho-pneumonia (fourth day of the disease).

Pathological Appearances.

Medulla.—The focus of degeneration described in Case 1 is beautifully seen here, and in several sections contrasts markedly with the outer group, which is practically normal in this case. The hypoglossal and seventh nuclei are quite normal. There is scattered degeneration in the groups of smaller cells as in all the previous cases (fig. 1, p. 812, and Plate I., figs. 1 and 2).

Heart.—There is considerable fatty degeneration, but not quite to the same extent that occurs in most of the other cases. There are several sub-pericardial hæmorrhages.

Case 8.

Clinical record.—W. G., male, aged 8; a patient in the Homerton Fever Hospital, suffering from faucial diphtheria. The onset of the disease was April 10, 1901. The heart began to fail on April 17; there was no vomiting or suppression of urine; the latter contained a little albumen. The pulse was, on the whole, over 100 in frequency. Death occurred from heart failure on April 22 (thirteenth day of the disease).

Pathological Appearances.

Medulla.—This case shows the same localised area of acute degeneration, but, on the whole, the individual cells do not show such gross degenerative changes as occur in the cases hitherto described. The toxemia in this case was probably of a less severe nature than in the above cases.

Heart.—Like the medulla, the heart only shows a small amount of degeneration; there is a certain amount of fatty change, and in other fibres cloudy swelling, but the vast majority of the fibres are normal. The capillaries and small vessels are much distended, and several hemorrhages are present.

Case 9.

Clinical record.—J. C., male, aged 1 year and 10 months; a patient in the Homerton Fever Hospital, suffering from extensive faucial, nasal, and laryngeal diphtheria, tracheotomy being performed on admission. The onset of the disease was June 19, 1901. The heart began to fail on June 25, and was about 120 in frequency. There were numerous subcutaneous hæmorrhages and bronchopneumonia. Vomiting began on June 28, and for twenty-four hours no urine was passed; the urine had previously contained albumen. Death occurred on June 28 from cardiac failure (tenth day of the disease).

Pathological Appearances.

Medulla.—The changes in the upper part of the nucleus ambiguus, as described in Case 1, are very gross indeed, and in one section through this region all the cells in the outer groups are affected, as well as those of the inner group, so that there is a complete patch of degeneration in this locality, affecting the whole of the cells. In other parts of the same section the remaining groups of cells are practically normal, showing only a few scattered degenerative changes.

Vagus.—Normal.

Heart.—There is extensive fatty degeneration and numerous hæmorrhages into the muscular substance of the heart wall, as well as great dilatation of the capillaries. The fatty change is most marked at the inner portion of the wall, and there are many subendothelial and subpericardial hæmorrhages.

Case 10.

Clinical Record.—F. B., female, aged 5; a patient in the Homerton Fever Hospital, suffering from faucial diphtheria. The onset of the disease was June 22, 1901. There were subcutaneous hæmorrhages, and albumen in the urine. The heart began to fail on June 25, and was rapid, sometimes 140 in frequency. Vomiting commenced on June 28, and the patient died on this day of cardiac failure (seventh day of the disease).

Pathological Appearances.

Medulla.—The degenerative changes here are very similar to those in Case 7, the focus of degeneration being in the usual portion of the nucleus ambiguus and nucleus centralis inferior; the remaining groups of multipolar cells are perfectly normal, and scattered degeneration occurs in the groups composed of smaller cells.

Vagus.—Normal.

Heart.—Fatty degeneration in some of the muscular fibres towards the inner portion of the heart wall; a few subpericardial hemorrhages.

Case 11.

Clinical record.—A. C., male, aged 4; a patient in the Homerton Fever Hospital, suffering from faucial diphtheria. The onset of the disease was August 2, 1901. There were several subcutaneous hæmorrhages; one-third albumen in the urine; and the heart, which was 80 to 140 in frequency, began to fail on August 7, in the early morning. There had been vomiting since August 5, and no urine was passed for twenty-four hours before death. Death occurred from heart failure on the evening of August 7 (sixth day of the disease).

Pathological Appearances.

Medulla.—In this case the medulla was cut into horizontal sections, and on looking through the series so obtained the whole nucleus ambiguus and nucleus centralis inferior could, with great accuracy, be mapped out, together with the hypoglossal and seventh nuclei. This case confirms all that has been described in Case 1, the patch of degeneration, consisting of grossly affected cells, being readily visible.

Vagus.—Normal.

Heart.—Marked fatty degeneration exists in many muscular fibres, together with cloudy swelling in others, but the majority of the fibres are normal; there are no hæmorrhages nor any alteration in the interstitial tissue.

Case 12.

This child died of asphyxia, and is included in the list for purposes of comparison.

Clinical record.—C. S., female, aged 9 months; admitted to

University College Hospital on February 17, 1901. The onset of the disease was February 15.

On admission, there was inspiratory stridor and retraction of the chest wall, with hoarse cough; the colour of the lips was good. The pulse was quite regular. There was soft, patchy exudation on the right tonsil; no rhinorrhæa nor enlargement of the cervical glands. Temperature 101°. Antitoxin, 6,000 units administered.

February 18.—The child had increased retraction, and one or two attacks of severe dyspnæa and cyanosis; tracheotomy was therefore performed, and complete relief resulted. There were no physical signs in the chest.

Between the above date and February 22, as the membrane separated, the child had numerous asphyxial attacks and many large dark-coloured pieces of membrane were removed from the trachea and bronchi, by means of long curved forceps, each time the child being completely relieved. Later on, most of the membrane was got up, but there still remained small shreds and putty-like muco-pus; the child, worn out by repeated asphyxial attacks, died during a severe one on February 22 (eighth day of the disease). The pulse was regular the whole time, and the heart free from physical signs.

Pathological Appearances.

Medulla.—There are a few slightly degenerated cells scattered throughout each group of cells in the medulla, the nucleus ambiguus having a few scattered and slightly degenerated cells in places, but the hypoglossal and seventh nuclei being quite normal. There are no grossly changed cells anywhere, and there is no indication whatever of any focus of degeneration in any group of cells.

Vagus.—Normal; fasciculus solitarius normal.

Heart.—There is no fatty degeneration whatever. In one or two places in the sections there is cloudy swelling of some of the muscular fibres, but these are very few in number and, as a whole, the fibres are practically normal.

Case 13.

This child died of asphyxia, like the previous case, and is included here for a similar reason.

Clinical record.—J. L., male, aged 4; admitted to University Hospital on March 26, 1901. The onset of the disease was March 24.

On admission there was a tiny patch of exudation on each

tonsil, inspiratory stridor and retraction of the chest wall, with cyanosis and restlessness; no physical signs in the chest. The pulse was quite regular. Temperature, 100°. No albumen in the urine.

Tracheotomy was performed and complete relief resulted. Antitoxin, 12,000 units administered. Between admission and March 29 numerous attacks of asphyxia and cyanosis occurred, and each time this happened the tube was removed and the trachea cleared out with long, curved forceps. The membrane was soft and putty-like, and extremely difficult to extract. Vomiting occurred on several occasions. The child died during an asphyxial attack on March 29 (sixth day of the disease).

Pathological appearances.

Medulla.—There are scattered degenerated cells throughout the medulla as in Case 12, but no focus of degeneration in any group of cells.

Vagus nerve.—Normal.

Heart.—There is no fatty degeneration in any muscular fibres; in many places there is cloudy swelling, and these changes are more marked and of more frequent occurrence than in Case 12, but as a whole the heart muscle is almost normal.

SUMMARY.

In reviewing the pathological changes described above in the neuro-muscular mechanism of the heart, it is evident that the essential lesion is an acute degeneration of the cellular elements composing it, the nerve-fibres being unaffected. This degeneration is probably a direct result of the action of the toxins upon the nerve-cells and muscle-fibres.

As an explanation of the distribution of the fatty degeneration chiefly at the apex and inner portion of the ventricular wall, it may be stated that these parts of the heart wall are subjected to somewhat more strain than the remaining parts, and hence are more liable to undergo degenerative changes. The scattered changes in various nerve-cells in the medulla, which have been described, are such as might be expected to occur in many acute infections; but it seems

probable that the definite patch of degeneration in the large multipolar cells at the upper part of the medulla, which is common to the above eleven cases, is peculiar to acute diphtheritic toxemia. The reason why these particular cells are affected, whilst the cells of the hypoglossal nucleus and other multipolar cells are spared, is not quite obvious; it is, however, worthy of mention that it is essentially the severe faucial cases which die of acute diphtheria, and that the faucial muscles are probably innervated from some of the multipolar cells of the nucleus ambiguus, which cells would thus be exposed to excessive reflex stimulation, and hence rendered more liable to degeneration.

Whether such changes would lead to paresis of a voluntary muscle does not seem clear, but it is certain that they would exert a pernicious influence upon a heart which was already the seat of fatty degeneration. The amount of fatty degeneration coming on so very acutely in the heart, as is described above, would make it seem superfluous to look for any additional cause of death in acute diphtheria, especially as the exact origin of the cardiac fibres of the vagus is not known. The following considerations, however, seem to point to the fact that a grave disorder of the cardiac nervous mechanism is at work:—

(1) If the pulse of a patient suffering from cardiac failure at any stage of diphtheria be very frequently examined during the day and night, it will be found that its character both with regard to frequency and regularity varies considerably from hour to hour. Sometimes it is quite regular, and soon after becomes extremely irregular, and this variation is sometimes noticed during actual observation. The relation of frequency to irregularity is by no means constant, but in most cases, especially in the acute toxic stage of diphtheria, on the whole the irregularity is associated with a slowing of the pulse, and even in these cases irregularity may occur with a rapid pulse; in other cases of heart failure the pulse is rapid during the whole time.

The following table shows this variability in the pulse on the fourteenth day of the disease in a case of moderately severe diphtheria:—

```
Time.
                                           Frequency.
                                                               Regularity.
                                                           very irregular.
                                                           regular.
                                                           irregular.
                                                           slightly irregular.
November 13, 1901
                                                           regular.
                                                           irregular.
                                                            slightly irregular.
                                                            very irregular.
                                                            irregular.
                                                            regular.
                                                            slightly irregular.
                                                            irregular.
```

In some cases it seems as if these changes come on in definite attacks of irregularity, as if due to the rhythmic action of the nervous system.

(2) The stimulation of a normal vagus acting on a normal heart causes a slowing of the pulse, and section of the vagi causes acceleration; and it might therefore be argued that an irritative lesion of the medulla should cause slowing and a paralytic lesion acceleration of the pulse. This, however, by no means proves what would be the effect of irritation or paralysis of the vagus upon a degenerate heart in such a complicated pathological condition as obtains in diphtheria. It cannot, moreover, be definitely stated whether the acute changes described above would produce irritation or paralysis of the vagus; it is, however, quite likely, as all stages of degeneration are found at the same time, that both irritative and paralytic effects may be felt by different portions of the heart at the same time, and that in some cases an irritative effect may preponderate whilst in others a paralytic effect may be chiefly evident. It is therefore impossible to state what the condition of the pulse would be under such circumstances; but the probability is that irregularity of action would be the prominent feature, that this irregularity would be subject to great variation in degree, and that in some

cases a slowing of the pulse might be expected and in others an increased frequency.

- (3) This irregularity of the pulse is not as a rule accompanied by any symptoms of cardiac distress, and in some cases the irregularity is continued for a very considerable time after convalescence is established, the patient feeling perfectly well, although sudden death may sometimes occur.
- (4) Paralysis, whether coming on in the acute or convalescent stage, is frequently associated with irregularity of the pulse, and this irregularity has the same characters as when it occurs alone in the acute stage of the disease; the cases in which the pharynx is paralysed are especially associated with irregularity of the pulse.
- (5) To quote a passage from "Ringer's Therapeutics" (page 12):—
- "The irregular pulse is very rare in children under twelve, though the conditions which produce it in adults are well marked."

Fatty degeneration would certainly account for the dilatation of the heart which is so frequently seen, but I hardly think that the chief symptom of this condition would be irregularity of action, especially as the subjects are almost invariably children.

The following reasons prove that the changes in the nerve-cells of the medulla described above are ante mortem and not post mortem, or the result of staining.

- (1) Medullæ taken from the body two hours after death show all the degenerative changes.
- (2) Other methods of staining in addition to that of Nissl show the gross changes.
- (3) The distribution of the degeneration is the same in all cases.
- (4) The amount of degeneration is proportional to the degree of toxemia of the case.
- (5) In the same slide normal and abnormal cells are seen side by side, and certain nuclei are invariably spared.
- (6) All stages of acute degeneration from early chromatolysis to gross degenerative changes are seen side by side in the same slide.

(7) These degenerative changes can be distinguished from those due to *post-mortem* decomposition.

Conclusions.

- (1) In acute diphtheritic toxemia there occur scattered acute degenerative changes in those nuclei of the medulla oblongata which are composed of the smaller variety of nerve-cells, including the sensory nucleus of the vagus.
- (2) The nuclei composed of large multipolar cells are quite normal, with the exception of the nucleus ambiguus and nucleus centralis inferior.
- (3) The degeneration in the nucleus ambiguus is very scattered and slight at its lower part, but towards the upper end it becomes more marked, and there is a definite grossly degenerated focus at its upper and inner aspect; in this focus of degeneration a little higher up is included the nucleus centralis inferior.

It is exceedingly probable that the cardiac fibres of the vagus originate from this region.

- (4) In this focus of degeneration there are a few scattered normal cells and a few cells showing the slighter degenerative changes, but the majority of the cells are grossly affected.
- (5) The amount of degeneration in each case varies with the degree of toxemia. In those cases which die as a result of the severity of the toxemia, the degeneration is very gross; but in those which die from an accidental complication, there may be little or no degeneration. It is probable that in the moderately severe cases which do not die, but in which the toxemia is rendered evident by an irregularity of the pulse, there are degenerative changes of a similar character, but of a slighter nature than is seen in the more malignant forms of the disease.
- (6) The ganglia of the vagus nerve show little or no degeneration, and when this does occur it is comparable to that seen in the smaller cells of the medulla.
- (7) There is no degeneration in the vagus nerve itself, and this is what would be expected, as all the cases died at

an early stage of the disease before any nerve degeneration would have time to show itself.

- (8) The heart in the more toxic cases shows marked fatty degeneration. (a) This change is found both in auricles and ventricles, and in greatest abundance towards the apex of the heart; it is most marked in the papillary muscles and towards the inner surface of the heart wall; (b) all the fibres, even in the most thickly degenerated area, are not affected, but markedly degenerated fibres are seen lying next to perfectly normal ones; and mixed up with these are fibres showing only cloudy swelling.
- (9) In the less toxic cases there is no fatty degeneration; but many fibres show cloudy swelling, although as a whole, these fibres are very small in number when compared with the normal fibres.
- (10) Congestion of the capillaries and small blood-vessels, with a few hæmorrhages, occur in some of the more toxic cases, the hæmorrhages being into the muscular substance, or under the peri- and endocardium. No nerve degeneration nor degeneration of the walls of the smaller vessels is present.
- (11) The degree of degeneration in the medulla runs pari passu with that in the heart.
- (12) All these acute degenerative changes may occur within the first few days of the disease.
- (13) The irregular pulse and fatal syncope of acute diphtheritic toxemia are probably due to the disturbed innervation of an acutely degenerate heart; the cardiac dilatation is the result of weakness of the heart wall and the irregularity of action chiefly of nervous origin.

In conclusion, I wish to express my very great indebtedness to Dr. Mott for allowing me to work in the splendidly equipped laboratory at Claybury; to the physicians of University College Hospital for allowing me to use the notes and specimens of the cases; to my brother, Dr. J. Shaw Bolton, for numerous hints and great practical assistance in the work; and to Drs. Goodall and Basan, of the Homerton Fever Hospital, for supplying me with the specimens and notes of six of the cases.

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DESCRIPTION OF PLATE I.

Fig. 1.

Micro-photograph of the right-hand three of the four cells seen in fig. 1 (page 812) (nucleus ambiguus of Case 7). All these cells are quite normal. In the topmost cell are seen the central nucleus and nucleolus, the large Nissl-bodies, the well-defined concave borders of the cell, and the cell processes. The nuclei of the two lower cells have been retained in an adjoining section.

Fig. 2.

Micro-photograph of the ringed cell seen in fig. 1 (page 812) (nucleus ambiguus of Case 7). This cell shows acute degeneration. The nucleus is excentric, the cell is commencing to swell, and the protoplasm is uniformly stained.

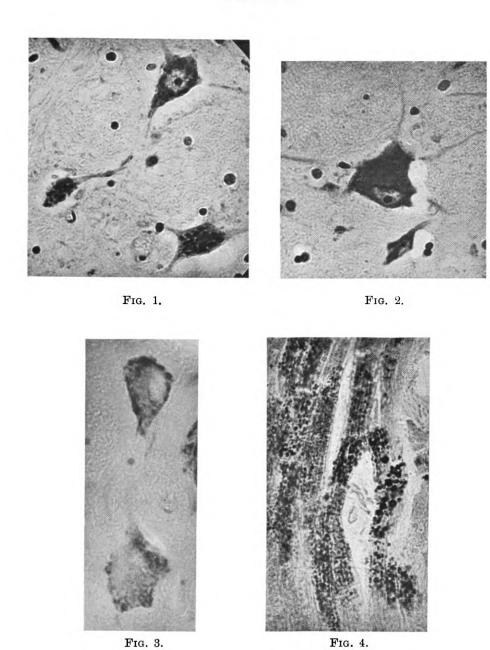
Fig. 3.

Micro-photograph of two cells from the nucleus ambiguus of Case 6. In the upper cell the nucleus is excentric, there is central chromatolysis, several Nissi-bodies still remaining round the periphery of the cell, and the whole cell is swollen, the normal concave borders having the appearance of being blown out. The lower cell shows chromatolysis, and is commencing to swell, but the concave borders can still be distinctly seen; the nucleus has unfortunately been retained in an adjoining section.

Fig. 4.

Micro-photograph of section of heart wall (Case 3). The figure represents a portion of the inner part of the wall of the left ventricle about 1 in. from the apex. There is extensive fatty degeneration of the majority of the muscular fibres seen; at one place towards the centre of the photograph, the droplets of fat are very large, and at that spot the muscle fibre is practically disintegrated.

PLATE I.



Pathological Changes in the Medulla Oblongata in Acute Diphtheritic Tox \pmb{x} mia.

To face p. 834

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SYSTEMATIC EXAMINATION OF THE CENTRAL AND PERIPHERAL NERVOUS SYSTEM AND MUSCLES IN A CASE OF ACUTE ALCOHOLIC PARALYSIS WITH MENTAL SYMPTOMS.

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THE case here reported was investigated by me in the latter part of the year 1900, the microscopical work being carried out in the Claybury Laboratory, at Dr. Mott's kind invitation. A brief abstract of the notes has already appeared in a paper in Brain, in which I have also given an account of two other cases of alcoholic neuritis of somewhat different type, and have attempted some discussion of certain of the problems presented in connection with the pathology of this disease. The present communication is now devoted to a detailed clinical and pathological report of the first of the three cases there described.

A somewhat more than ordinary value attaches to this case by reason of the combination of several circumstances in connection with it. Clinically, it bore the aspect of a severe multiple neuritis in a patient with marked alcoholic history, and the diagnosis of alcoholic paralysis seems to be placed beyond doubt by the details of the clinical and pathological examination. The disease was somewhat unusually acute, as is shown by the history and also by the morbid appearances. It was directly fatal in itself, and was entirely uncomplicated. There was no associated infective process, such as pneumonia or tuberculosis, and no suspicion arises of the presence of any prime causal factor apart from the long-continued alcoholic excess. The autopsy was made

^{&#}x27;" On Changes in the Central Nervous System in the Neuritic Disorders of Chronic Alcoholism," Brain, Autumn, 1902, pp. 326-363.

sufficiently soon after death to exclude any contamination of the pathological appearances with the results of post-mortem change. The case accordingly fulfils the conditions requisite for the profitable study of the essential lesions of the disease in their earliest stages, not only in the cranial and spinal nerves, but also in the central nervous system and muscles. Especially do the observations appear to be of interest in their application to the question as to the position and relations which the central nervous changes in alcoholic neuritis hold with regard to the familiar peripheral nerve lesions of the disease.

The patient was a well-built, we -nourished woman, 32 years of age, who was admitted to Colney Hatch Asylum on September 7, 1900, suffering from severe multiple neuritis. The following history was obtained:—

She was married, and had had one child six years ago, which died of convulsions at the age of nine months; she had since had two miscarriages. For over eight years she had been a notorious gin drinker, and had had several attacks of delirium tremens. She had suffered from fits from time to time while under the influence Her parents are stated to have been very sober people of drink. -almost total abstainers. Her father's brother became insane at an advanced age, drink being the assigned cause. No other case of insanity or nervous disease is known in the family. patient herself had been in Colney Hatch Asylum for about seven weeks in the summer of 1898, as the result of drink. She was then violent, and had suicidal and homicidal impulses. A few months ago she was in a workhouse infirmary on account of weakness and pains in the legs, but was said not to have been very ill, and at any rate she was only detained a short time. After this she appears to have remained in fair health until five weeks ago, when she again took to her bed with the same symptoms. Becoming worse she was removed to a workhouse infirmary, and I learn that on admission "she was in a comatose condition, the right side of her face being drawn up, so that apoplexy was suspected; this lasted forty-eight hours, when she came round; the lower extremities never regained their power, but the power of the arms returned, and she had a good grip. After the tenth day the facial paralysis disappeared; this was thought to confirm the diagnosis. No epileptiform convulsions were observed."

After being at the infirmary a fortnight she was removed to Colney Hatch Asylum on account of mental symptoms, and here she first came under my care.

On admission she was in a very weak and helpless condition. She could neither stand nor walk, nor raise herself in bed. lay on her back, the legs extended and completely paralysed. The arms were very weak, and she could only move them in a feeble, aimless way. There was marked dyspnœa, and she had to be propped up with pillows. She could only speak with effort. She could not feed herself owing to the weakness of the arms; swallowing was difficult, and she was unable to take solids; liquid food showed a tendency to enter the larynx and set up coughing. There was no vomiting. The bowels were confined. The pulse varied from 120 to 160 or 170, and was very small, short and compressible, regular in time, but somewhat irregular in force. At first the heart's impulse could be felt in the normal position; there was a slight extension of the deep dulness towards the right, and there was a little pulsation in the veins of the neck. The cardiac sounds were rather short, but clear and well heard. The respiration rate was Respiratory movement was almost limited to the upper part of the chest, the diaphragm being partially paralysed, and the abdomen being slightly sucked in during inspiration. There was no cough. Physical examination of the lungs revealed nothing abnormal. There was no distension or retraction of the abdomen; the abdominal wall was flaccid, and showed universal tenderness to pressure, apparently muscular. The liver dulness was normal. The urine was clear, of an acid reaction, and a specific gravity of 1028, and was free from albumen. The temperature showed a continuous slight elevation, varying from 99° to 100°; on one occasion, two days before death, it reached 102°. She became progressively weaker, the cardiac dilatation increased, involving the left side, so that the dulness extended nearly two inches beyond the left nipple line; the face became cyanosed, and râles and defective air-entry were observed at the bases of the lungs. Death occurred on September 15, eight days after admission to the asylum. The patient was conscious up to the last.

The illness, at any rate its acute phase, appears to have had a duration of about six weeks. She was laid up three weeks at home, she was in the infirmary a fortnight, and in the asylum one week.

The symptoms and physical signs referable to the nervous system will now be detailed, as they were observed in the last week of life.

NERVOUS SYSTEM.

Mental symptoms.—Her mental state, though not capable of definition in a single term, approximated rather more to a delirium than to a dementia. It was for the most part characterised by confusion and wandering of mind, especially at night. She moved her head about restlessly at times, muttering to herself and calling out to imaginary persons. It is probable that there were auditory hallucinations. From this wandering she could be easily roused; she paid attention to questions, and answered fairly well. was well-marked defect of orientation both as to time and place. Sometimes she thought she was in a public house, of which she gave the name. At other times she said she was in the infirmary, and that she had been there several weeks. The medical certificate on which the patient was admitted stated that while still in the infirmary she thought she was in Colney Hatch, her mind then evidently recurring to the time of her previous sojourn in the asylum. I noticed that her mind became much clearer from time to time, especially in the early part of the day; and just before death she recognised those about her, she knew she was in Colney Hatch, and approximately how long she had been there. She had the delusion that she had recently been confined, and that her baby was in the bed with her. There were also illusions as to the identity of persons; for example, she thought the charge attendant of the ward was the midwife, "Mrs. N." Once she asked her to "take off these gloves—they are too tight." delirious, she had occasional involuntary micturition, but there was control over the bladder during the lucid intervals. A mental disorder of this type is characteristic for alcoholic cases presenting a neuritic condition.

Motor Symptoms.

I.—Irritative.

There were occasional twitchings of the facial muscles, and there was marked subsultus tendinum of the arms and hands from time to time. Occasionally one observed a short series of involuntary clonic movements of both arms simultaneously, accompanied by lateral movements of the head; these movements seemed to cause pain in the arm muscles, so that the patient cried out; there was no loss of consciousness. These attacks lasted several seconds; five such were observed in the course of half an hour on the morning of the day before death.

II.—Paralytic.

Cranial nerves. Third, fourth, and sixth nerves.—The pupils were equal, regular, and somewhat dilated; there was no limitation or sluggishness of any of the pupillary movements. There was slight lateral nystagmus, possibly to be accounted for by the fact that there was some weakness of the right external rectus muscle, causing convergent squint. This weakness, though sometimes well marked, was often scarcely noticeable. No paresis of other eye muscles was detected. The patient made no complaint of double vision.

Fifth nerve.—There was tremor of the jaw, and weakness of the muscles of mastication.

Seventh nerve.—There was slight general weakness of the facial muscles, the cheeks being smooth, puffy and expressionless. The paresis was at times more marked on the left side. The lips were tremulous and articulation slightly imperfect.

Ninth and tenth nerves.—There was some difficulty of swallowing. Speech was thick and husky, and there was partial aphonia. The heart's action was very rapid.

Twelfth nerve.—The tongue was tremulous, but could be protruded well, and no lateral deviation was observed.

Spinal nerves. Arms.—All muscles of the upper extremities were weak, flabby, and moderately wasted, especially the triceps, interossei, and muscles of the thenar and hypothenar eminences. They were all tender to pressure, and any movement of the limbs was painful. The elbows were flexed, there was marked wrist-drop, the first and second fingers were extended, and the third and fourth flexed. There was much coarse tremor of the arms and hands.

Legs.—There was complete paralysis of all muscles of the lower extremities. The legs were extended, and there was marked footdrop. All the muscles were flabby and moderately wasted, and the calf muscles were tender to deep pressure. Passive movements caused pain.

There was partial paralysis of the diaphragm.

The sphincters were not affected.

ELECTRICAL REACTIONS OF MUSCLES.

All muscles of the upper extremities reacted to faradism, but required a stronger current than normal.

Reaction to faradism was abolished in all the muscles of the lower limbs, and a strong faradic current caused no pain.

SENSORY SYMPTOMS.

I.—Subjective.

The patient complained at times of pain in the abdomen and in the limbs, especially the arms. Movements of the limbs were very painful. The hands felt as if they were in tight gloves.

II.—Objective.

Vision and hearing were fair. No abnormality of smell or taste was observed.

Ophthalmoscopic examination revealed normal fundus in each eye.

Cutaneous sensation was unimpaired on the face, neck, and trunk. There was slight diminution of tactile sensibility on the forearms and hands, but no analgesia of the upper extremities, a pin-prick being accurately localised. Cutaneous anæsthesia and analgesia were almost complete over the whole of the lower limbs.

Reflexes.—The pupillary and abdominal reflexes were present, but no plantar reflex, knee-jerk, Achilles jerk, triceps or supinator longus jerk, or ankle clonus could be obtained on either side.

Clinical examination of nerve-trunks.—There was marked tenderness of brachial plexuses, musculo-spiral, ulnar, and posterior tibial nerves.

Trophic symptoms.—The skin of the legs was white and glossy, and rather moist. The face, neck, chest, and arms sweated profusely. There was moderate ædema of legs, ankles, and dorsum of feet. There were small blisters over the inner border of the left heel and over the right internal malleolus present on admission to the asylum, but healed before death.

POST-MORTEM NOTES.

Rigor mortis just commencing. No post-mortem staining. No bruises or bed-sores. Body well nourished; subcutaneous fat fairly abundant. Thoracic and abdominal muscles of a good colour. Calvaria and dura mater normal; slight excess of intracranial fluid. Barely appreciable opacity of pia-arachnoid over parietal and frontal lobes; no adhesion of membranes; two or three minute sub-pial hæmorrhages; no recognisable atrophy of cortex; brain fairly well convoluted, weight, 42 oz.; consistence of brain-substance normal; cerebral vessels healthy. Pericardium normal. Heart 8 oz.; no valvular lesion; right side distended with fluid blood; left ventricle contracted and empty. Muscle

substance pale, flabby and greasy; slight yellow striation of columnæ carneæ and musculi papillares. Arterial system normal. Pleuræ normal; no adhesions. Lungs normal, save for some hypostatic congestion of bases. Right lung 18 oz., left 12½ oz. Peritoneum normal. Liver 52 oz., fatty and somewhat cirrhotic; surface slightly nodulated; substance firm; colour pale yellowish, mottled; capsule thickened on under surface. Spleen 4 oz., normal. Kidneys 7 oz. each, greasy-looking on section; maroon colour; no thickening of capsule; slight adhesion in places; cortex not diminished. Mucous membrane of stomach very vascular and congested over greater part of surface; here and there it seems to have undergone chronic inflammation and replacement by white fibrous structure. Dilatation of large intestine. No intestinal congestion or ulceration seen. Uterus and ovaries small, apparently normal. Bladder normal.

MICROSCOPICAL EXAMINATION.

For this the methods employed were formol-paraffin-Nissl (or Unna's polychrome methylene blue) for the nerve-cells; also Heidenhain's iron-hæmatoxylin method. For fibres of central nervous system Marchi's method and a modification of the Schäfer-Pal process. For the vessels and neuroglia, the van Gieson and Heidenhain-iron methods; also hæmatoxylin and eosin. For the peripheral nerves, Marchi's method throughout with or without subsequent Stræbe, van Gieson, or hæmatoxylineosin staining. For the muscles, and also for the viscera, Marchi and hæmatoxylin-eosin.

Cerebral cortex.—The minute structure of the cortex as a tissue shows no great deviation from the normal; there is no disturbance of the cell layers, or of Meynert's columns; glia changes are slight, and no definite changes have been made out in the cortical blood-vessels. Cell changes are present, but are neither extreme nor universal. The following description applies to Nissl sections from the highest parts of the ascending frontal and parietal convolutions of both sides. A number of the Betz cells are normal; in others the stainable granules are somewhat reduced in size, the change not amounting to a definite chromatolysis. But in a considerable number there is a marked breaking up of the chromophile substance in the central and basal parts of the cell, but remains of the Nissl granules are present at the periphery and apical parts of the cell, and on the apical process. In such cells the nucleus is displaced to the side or

upper extremity. The nucleus is pale; the nucleolus and nuclear membrane stain well and clearly. Whether combination of appearances represents here a secondary lesion analogous to the "reaction at a distance," I am loth to state. Many of the other pyramidal cells show well-marked disintegration of the Nissl substance with some swelling and dislocation of nuclei. Many of these pyramids are beset with small cells lying inside the pericellular space and closely applied to the cell, as many as eight or nine being sometimes seen around a single individual; these are doubtless identical with those described as "free nuclei," "satellites," or by French writers as "neuronophages." Though mainly neuroglia cells, some appear indistinguishable from leucocytes. Sometimes they lie in pits in the surface of the cell, but whether this denotes phagocytic action is not clear. The same excess of satellites is also seen in sections of the medulla, but otherwise no definite glia changes can be made out anywhere.

Nerve-cells of the medulla and pons.—Similar nerve-cell changes are well marked in the nuclei of the cranial nerves. Many cells of the vagus, hypoglossal and sixth show varying degrees of central chromatolysis with swelling and lateral displacement of the nucleus. Those of Deiters' nucleus and the dorsal nucleus of the auditory nerve are less affected, and the cells of origin of the facial nerves seem almost unchanged. But the large cells of formatio reticularis, and the cells of the median raphé, all show extreme changes of the kind described. None of these are normal.

Anterior horn cells of the cord.—The following description applies to those of the lumbar and cervical enlargements. All of these show very marked changes, except in a very few instances. At the third lumbar segment, many of the cells of the anterior median group appear to be normal, and show abundant large stainable masses, while the nucleus retains its central position. These cells are believed to be concerned with the motor innervation of muscles of the spine. But in all the cells of other anterior horn groups chromatolysis is practically complete, save in a few instances. No proper Nissl granules can be seen anywhere in the cell; the chromophile substance is broken down into a granular debris distributed throughout the cell body, but in general this debris is denser at the periphery of the cell, and at the extreme edge some greatly attenuated Nissl granules can be seen. In many cells, and probably in all, the chromatolysis begins in the centre around the nucleus, as the least affected examples show. I cannot satisfy myself that it ever begins at the periphery, or the

place of origin of the axis cylinder process. In advanced stages, the last remains of Nissl granules seen are those on the roots of the dendrites. The dendrites are frequently much attenuated and irregular, and appear as if withered away. The outline of the cell is often swollen and rounded, but may be irregularly shrunken. In the great majority the nucleus is displaced to the edge, against which it may be flattened; but more usually it is swollen and bulging, and appears partially herniated or extruded. The protruding surface of the nuclear membrane may then be crumpled or folded, and sometimes granular. The membrane and nucleolus stain well; the other nuclear contents are always pale. There is no tendency to disappearance of the nuclear membrane; the nucleus preserves its spherical form, except in association with extreme displacement, when it may be flattened.

In one or two cells only have I seen rupture of the membrane of the bulging nucleus, the nucleolus being seen in the act of escaping. I can find no instance of complete extrusion or loss of the nucleus. In any single section the number of cells showing a nucleus is proportionately small, even of those cells which appear from size and shape to have been cut well through their centre. For example, a section taken at random from the third lumbar segment of a thickness of 10 microns, shows 105 cells in the two anterior horns taken together; of these about seventy are of such size as to justify the assumption that they have been cut across near their centre; only nineteen of the whole number show nuclei, which are nearly always dislocated. Similar appearances are presented by sections from other segments of the cord. Even after making a considerable allowance for cells cut wide of their displaced nuclei, one might be inclined to infer that many had lost their nuclei altogether. To ascertain whether this was really so, the following method of investigation was adopted:—

A dozen consecutive serial sections were cut of a thickness of about 12 microns, and an outline drawing of the cells in the whole of one anterior horn was made from each of these sections by means of an Abbe "Zeichenapparat," using a low power of the microscope. The drawings being arranged in series, it was possible to trace any given cell through the several consecutive sections in which its successive slices were located. The cells were scrutinised with a higher power of the microscope, and whenever a cell with a nucleus was seen, a line was drawn across it in each of the drawings in which that cell was shown. In this way it was possible to be sure that every cell was examined. When the process was complete, it was found that every cell

which was wholly contained within the series of sections had been marked off; that only some of the cells in the sections at the extremes of the series failed to show a nucleus, and were not marked off, doubtless because the nucleus would have been found in adjacent sections; and that in the intermediate drawings of the series, including by far the greater number of the sections, all the cells had been marked off as being possessed of a nucleus. In every instance the nucleolus also was present. The same process was applied to sections from six different levels of the cord, with the same result, the total number of whole cells examined being very considerable. This, I think, sufficiently shows that in the present case there is no loss of nuclei.

In the large cells of the cervical and lumbar enlargements, the condition of central chromatolysis and nuclear excentricity is seen in nearly every cell. Sections from the dorsal and upper cervical regions show similar changes, though rather less extensive and severe. In general, there is some excess of yellow pigment, for which reason in Marchi sections many of the cells are stained dark brown.

I have only found two or three cells which show vacuolation; the vacuoles in these are small and inconspicuous, and are situated at the periphery of the cell, away from the nucleus.

In this case the condition of the cells as a whole appears capable of recovery, especially in view of the slightness of nuclear changes, and the invariable presence of the nucleus. It can scarcely be said of any given cell that it might not have returned to a normal condition, had the patient lived; though that some would have ultimately perished is of course not improbable.

The nerve-cells are not beset with "satellites," and there is no recognisable glia change in the cord.

The cells of Clarke's column show well-marked Nissl granules confined to the periphery of the cell; this appearance appears to be normal for these cells. The other posterior cornual cells are also for the most part normal.

Cells of posterior root ganglia.—The fifth and sixth cervical, fifth lumbar, and first sacral ganglia were investigated by Nissl's method. All show considerable changes in large numbers of their cells, perhaps a little more marked in the first sacral than in the other ganglia mentioned. Marked excentricity of the nucleus is frequent. Striking an average from the enumeration of cells in a considerable number of fields in a series of sections from all the ganglia examined, I find that of those whose nuclei are visible, about one-third show a lateral dislocation of the

nucleus. A slight degree of excentricity may possibly have no pathological significance, but no objection of this kind can apply to the great majority of those cells which here present this feature. For it exists in a very marked degree, and is accompanied often by distinct swelling of the nucleus, while the cell body shows evident chromolytic change. Nuclear changes proper are not noticeable.

The severity of the changes in the anterior horn cells will be found to accord with the extensive degeneration of motor peripheral nerve-fibres. And the widespread affection of the posterior root ganglion cells is in agreement, not only with the extensive degeneration of peripheral sensory fibres, but also with the degeneration in the posterior columns of the cord to be presently described. It may also be noted that the integrity of Clarke's cells and of the other posterior cornual cells accords with the absence of degeneration in the direct cerebellar tracts and in the endogenous posterior-column fibres respectively.

FIBRE DEGENERATIONS IN THE ENCEPHALON.

Sections from the upper and middle Rolandic regions of the cortex prepared by Marchi's method, show degenerated fibres here and there in the tangential system, and occasionally in places deeper in the cortex, but they are few and far between, and the amount of degeneration is small. There is some deposition of fatty matter in the pia mater. Other Marchi sections mordanted in iron-alum solution, stained with Kulschitzky's hæmatoxylin, and differentiated by Pal's method, show a slight atrophy of tangential fibres in places.

Sections from the internal capsule show a fair number of degenerated fibres in the motor tract at this level. Such fibres, however, are not nearly so numerous as those seen degenerated in the anterior limb of the capsule, which may be traced downwards, backwards and inwards into the anterior extremity of the thalamus.

There is a slight scattered degeneration in the central white matter of the cerebellum, better marked in the vermis than in the lateral lobe.

FIBRE SYSTEMS OF THE SPINAL CORD.

In sections stained by Marchi's method a moderate scattered degeneration is seen at all levels of the cord, principally in the posterior columns, and to a less extent in the pyramidal tracts.

Posterior columns.—The degeneration is well marked, but in every part the healthy fibres greatly outnumber the degenerated fibres.

In the sacral region the degeneration is chiefly observed in the angle just internal to the entrance of the afferent root, extending thence near the side of the gray cornu forwards and inwards to the ventral two-thirds of the posterior column, the more posterior and mesial region being scarcely affected.

In the lumbar region the degenerated fibres are very much more numerous, and congregate chiefly in the root zones, and in the more mesial parts, from the posterior surface forwards nearly as far as the central gray matter, but leaving intact the cornucommissural zones and a narrow band adjoining the median septum ("central oval area" of Flechsig). Flechsig's area is free from degeneration, though the parts immediately lateral to it are crowded with blackened fibres. The posterior column degeneration is more intense in this lumbar region than at other levels of the cord, and in the Marchi sections its distribution is plainly visible to the naked eye; Flechsig's area is conspicuous as a pale band in the middle line.

In the dorsal region the affected fibres are fewer, and are more diffusely scattered. More are noticed, however, towards the middle line than laterally.

In the cervical region the amount of degeneration increases again somewhat. It is most marked in the root zones, and in Goll's columns bordering the hindmost two-thirds of the median septum, especially about the mid-point between the central canal of the cord and the posterior surface, in the situation of the long fibres from the lumbo-sacral roots.

The cornu-commissural zones are not affected at any level.

In the lower part of the medulla there is very considerable diffuse degeneration in the funiculus cuneatus and funiculus gracilis, best marked in that part of the funiculus gracilis which borders the whole depth of the median fissure.

The distribution described shows that the posterior column degeneration exclusively, or almost exclusively, affects the exogenous fibres of the cord, i.e., the continuations of posterior root-fibres, especially those in connection with the limbs.

Next in importance to the posterior column degeneration must be considered a less marked degeneration in the *pyramidal tracts*. This is seen in their whole extent, but diminishes from above downwards. It is very noticeable in the medulla, especially in the decussation. In the cord it is seen both in the direct and in the crossed tracts. The blackened fibres are mostly of large size. A fair number of degenerated fibres are seen in other parts of the antero-lateral columns, especially in the cervical region scattered about near the anterior face of the anterior horn.

The direct cerebellar tracts are free from degeneration.

Degenerated fibres are fairly numerous in the gray matter of the anterior horns, especially in the lumbar region. A few are seen in the anterior commissure, and in the intramedullary portions of the roots.

The extramedullary portions of the anterior and posterior roots are almost normal. In the lumbar region they contain, however, a few degenerated fibres. In the whole bundle of posterior roots on one side of the cord seen cut across in a section of the cord at the level of the third sacral segment, I counted about a hundred fibres which showed a definite degeneration, and about half as many in the anterior roots. These are, of course, quite insignificantly few compared with the enormous number of healthy fibres among which they are scattered, but they are sufficient to show that the nerve-roots are not free from degeneration. In some of the lower cervical roots a very few fibres are seen to be affected.

The blood-vessels of the cord are generally congested, but I have searched in vain for changes in their coats. No neuroglial or meningeal changes have been observed in the cord.

Weigert-Pal sections of the cord show nothing of note.

The accompanying diagrams, fig. 5, show the distribution of the cord degeneration. Drawings were made of sections from the different levels under the Edinger projection apparatus, and the whole reduced to scale.

PERIPHERAL NERVES.

In considering the nerve changes, it will conduce to a better understanding of the morbid process to keep in mind one or two points in the history and clinical aspect of the case: namely, the fact that there had been a slight attack a few months previous to the acute fatal illness, and that the former was one which affected the nerves and muscles of the legs, while the latter involved nerves and muscles in all parts of the body, and at the end the sensory and muscular paralysis was much more complete in the lower limbs.

The nerves investigated were: the vagi, the left phrenic, and the following nerves of the left arm and leg—musculo-spiral, median, ulnar, anterior tibial, posterior tibial, and a small cutaneous branch of the posterior tibial distributed to the skin over the

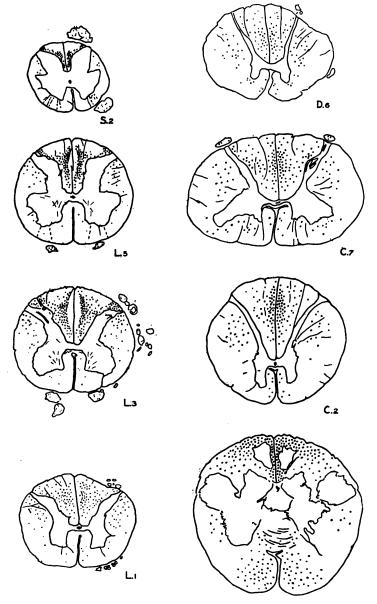


Fig. 5.

A series of drawings, on the same scale, of sections from seven levels of the spinal cord and from the lower part of the medulla, in which the Marchi findings have been diagrammatically represented.

region of the left heel where during life there had been a trophic blister.

In all these the morbid process is clearly a parenchymatous degeneration. In Marchi sections, the myelin is seen split up into segments and droplets, mostly remaining in situ in the fibre, and stained black by the osmic acid. Black myelin debris is also often seen scattered about between the fibres. The axis cylinders of affected fibres are in places tortuous and irregularly swollen, and they may be stained black. Here and there an axis cylinder may show a breach of continuity. The sheath nuclei of the degenerated fibres are greatly multiplied. It is quite plain, from a survey of the sections of all the nerves examined, that the process begins essentially as a degeneration of the nerve-fibres themselves. In all the nerves the fibre change is the only noticeable feature in the sections. Interstitial and vascular changes do indeed occur, but they are quite in the background. The only nerve examined in which they are at all appreciable is the little cutaneous branch to the heel above mentioned. In this there is a new growth of young connective tissue and minute vessels among the fibres in the nerve-bundles. At first sight, the medium-sized blood-vessels running in the nerve-sheaths appear to be thickened in their middle and outer coats; but the condition here seems to be physiological rather than pathological; their coats are thickened to withstand the considerable pressure to which they are subjected by the weight of the body in the erect position and to prevent occlusion of the lumen. There is no nuclear proliferation in the endothelial lining, or in the other coats of these In this nerve a number of the nerve-fibres seem to have altogether disappeared, the space left being filled by the young interstitial overgrowth. The amount of blackened myelin is less than in the other nerves, probably because the degenerated material has been for the most part absorbed. In the main trunk of the posterior tibial at the level of the malleolus the interstitial change can only be detected on very careful examination; yet here the myelin change is intense and universal, no normal fibres can be seen, though comparatively few have disappeared altogether. The condition found in the anterior tibial is essentially similar.

The median (two inches above the condyles of the humerus), the musculo-spiral (in the lower third of the arm), and the ulnar (at the wrist) all show a degeneration as extensive as that in the tibials, but more acute; for the fibres are less disintegrated, the clumps of myelin remain mostly in position in the fibres, less loose

dėbris being seen between the fibres. There is scarcely a normal fibre visible anywhere, and the whole microscopic field is dark with the black myelin drops.

Yet with all this there is, in the musculo-spiral and median, an entire absence of interstitial change. Only in the ulnar, which was examined low down in the limb, there is a very slight increase of connective tissue nuclei. In the others the nuclear proliferation is seen on careful examination to be confined to the nuclei of the primitive sheaths of the fibres, and is an essential feature of the degeneration of the fibres themselves. In none of the nerves is there any nuclear proliferation outside the nerve-bundles. The small vessels are full of blood; their coats are not altered. It is worthy of remark here that all the upper limb muscles reacted to faradism.

The left phrenic, at the level of the root of the lung, shows a few degenerated fibres standing out conspicuously in the section, with increase of their sheath nuclei, but the great majority of the fibres seem healthy.

The left vagus, in the neck, shows degeneration of a considerable proportion of its fibres, but the process is less extensive than in the arm nerves.

The right vagus is somewhat less affected than the left, nearly half the fibres showing changes in their medullary sheaths.

No interstitial change is observable in any of these last three nerves.

None of the nerves presented any naked-eye change at the autopsy. In none of the portions stained have I observed any inflammatory effusions into the sheaths of the nerves, such as have been referred to by Sharkey (Path. Trans., 1888), Gibson and Fleming (Edinburgh Hospital Reports, 1895, p. 415), and Fleming (Brain, 1897).

VOLUNTARY MUSCLES.

The changes in the muscles are of interest, on account of their acute character, and seem to call for a detailed description, the more so as precise accounts of the exact changes in the musculature in alcoholism are scanty, at any rate in the English language.

As in the nerves, so in the muscles, we have to do with degenerative change, and with interstitial change; of these the former is very much the more important and severe.

Here, too, it will be well to bear in mind the fact that the muscles of the legs were more completely paralysed than those

of the arms in the last stages of the disease, and also that they had been affected in the previous slight attack.

The muscles investigated were the diaphragm, portions of the small muscles of the thumb, the triceps, and the soleus. Marchi's method was employed, with or without subsequent staining with hæmatoxylin and eosin. No naked-eye alteration was noticed in any of these muscles at the *post-mortem* examination. Of those mentioned, the diaphragm and triceps seem to show a less advanced stage of degeneration than the thenar muscles, while the soleus shows a more extreme degree of change.

The diaphragm and triceps may be considered together, as they present precisely similar appearances. The healthy fibres are very few in number. In those that are altered, the deviations from the normal are of very varied degree, not only in different fibres, but also in different parts of the same fibre. The essential feature is the deposition of minute droplets of fat in the muscle substance, which are stained black by the osmic. These droplets vary somewhat in size, but are all quite small. In typical fibres they are arranged in short longitudinal rows, emphasising the natural longitudinal striated appearance. In the early stage they are most numerous at the periphery of the fibre, appearing later in all parts of the body of the fibre, in enormous numbers. Some look as if they were outside the fibre, lying upon its surface. Yet a considerable number of fibres do not show this arrangement of the droplets in rows, except occasionally here and there, nor do they exhibit this predilection for the peripheral parts of the fibre. Even in the earliest stage, as also in the later stages, they may be scattered irregularly and indiscriminately through the fibre. The calibre of the fibres varies greatly, even in different parts of the same fibre, and particularly in the early stages of the fatty change. Where the same fibre appears fairly normal in one place and shows marked fatty change in another, it is usually distinctly swollen in the more degenerated part. But of those affected throughout all of their length seen in the section, some are swollen throughout, and some are uniformly diminished in calibre. Variations in diameter in different parts of fibres with well marked universal fatty change are not common. There seems to be no constant relation between the character of the arrangement of the droplets, whether in orderly rows or in an irregular fashion, and the calibre of the fibre. Fibres presenting these various appearances are mixed together quite haphazard, and are not grouped in any way.

The normal transverse striation persists even after the development of marked fatty change. It is to a considerable degree obscured by the crowds of black points in the Marchi preparations, but when it cannot be distinguished with ordinary daylight illumination it may usually be made out by using a lamp, focussing the conductor carefully, and stopping down the diaphragm. But in a few of the fibres there is veritable disappearance of the cross striation. Even the most careful examination may fail to reveal it in some of the fattiest parts of some of the least affected muscle fibres, when other places in the same fibre show wellmarked striation, and little or no deposit of fat. This conjunction of circumstances would seem to put out of court the possibility that the abolition of the striation may be an artificial On the other hand, the normal striation often remains in fibres with universal severe fatty degeneration. None of the muscles examined show the development of any larger fat drops. The fat is always in the form of minute particles, both in the earliest and most advanced stages, though they seem to increase slightly in size as the degeneration advances.

In the triceps there is a very slight increase of the interstitial connective tissue nuclei. This is absent or doubtful in the case of the diaphragm. There is a notable increase in the number of the nuclei of the sarcolemma of the affected fibres.

The condition of the small thumb muscles is not markedly different from that described above. The amount of intrafibrillar fat is however greater, and no normal fibres are found. The interstitial increase is more evident, especially about the small blood-vessels. There does not appear to be any atrophy or shrinkage of the fibres. In transverse sections they show a general replacement of the normal polygonal outline by a more rounded or oval form, and the preponderance of the fat droplets near the margin is fairly well seen.

In the soleus we find a distinctly different state of affairs. The fat droplets are of the same minute sort, but are much fewer, and the longitudinal arrangement is not so common. The transverse striation is to a great extent lost. The muscle substance is less transparent than normal, and presents a translucent jelly-like, homogeneous, or hyaline appearance. If there is any general change in the calibre of the fibres, it would appear to be in the direction of an increase. The young interstitial overgrowth is fairly well marked. The condition of this muscle may be taken to be a more advanced stage of degeneration than that in the other muscles described, the deposited fat having, to a

great extent, been absorbed. There is no disappearance of fibres.

It may be again remarked that faradic excitability was abolished in the case of the soleus, but was preserved in a modified degree in the triceps and intrinsic thumb muscles, in spite of the acute and almost universal degeneration of their fibres.

Heart.—Sections from the wall of the left ventricle and from one of its large musculi papillares show general cloudy swelling of the cardiac muscle. Fibres showing acute fatty degeneration are also present, but the amount of fatty change seems scarcely so great as one might have expected from the naked-eye appearance of the heart at the post-mortem examination.

The *liver* shows a moderate cirrhosis of portal distribution, and also some fatty infiltration. No fatty degeneration of the liver cells has been detected.

Sections from one of the *kidneys* reveal slight fatty change in some of the convoluted tubules of the cortex, and a few fatty casts are found in the medulla. All the vessels are much congested.

Sections from the wall of the stomach show some atrophy of the glandular elements of the mucous membrane, with increase of interglandular connective tissue. All the vessels are engorged with blood, and round a few of the smaller ones are seen aggregations of inflammatory cells.

Blood.—Dr. Mott examined some of the fluid blood obtained from the jugular veins at the autopsy, and reports that it contained a very considerable quantity of choline. Abundant tetrahedral and octahedral crystals of its compound with platinic chloride were obtained.

REMARKS.

There seems to be no reasonable doubt as to the diagnosis in this case. It is a typical example of that group of cases which we are accustomed to regard as alcoholic polyneuritis, and presents the characteristic lesions of this disease in a particularly acute form.

In connection with the changes in the peripheral nerves I would lay stress on their essentially degenerative nature. There is no essential inflammatory factor in the disease. The interstitial and vascular changes are slight, and are only found in those nerves which the clinical and microscopical examination alike show to have been longest affected. More-

over, they are only well marked in the most peripheral parts of these particular nerves; the myelin disintegration is equally, or even more marked in the parts proximal to these, and in the other nerves which show no interstitial change. The interstitial changes are too trivial in amount to be the cause of so much degeneration. They would appear to be an end-product, representing the results of a natural attempt at repair, in which the more lowly-organised supporting tissues participate.

The changes in the muscles are also primarily degenerative in origin. In this case, in which death resulted early, the only striking feature in the sections is the intense widespread acute fatty degeneration of the muscle-fibres. The fatty change is the essential lesion. It has hitherto received little attention; Judson Bury, in his article in "Allbutt's System of Medicine," makes no reference to it, nor is it mentioned in the paper of Hamilton Wright and Orange in the last volume of these Archives. The interstitial fibrosis and impairment of cross striation commonly described as the characteristic muscle change in alcoholic neuritis is only an end-product. In the present case, the upper limb muscles and diaphragm, which were not completely paralysed, show an intense fatty change; but at the same time there is only a very slight amount of interstitial abnormality, multiplication of the nuclei of the fibre sheaths being seen only just In the leg muscles, which were completely commencing. paralysed, and which the history shows were those longer affected, the fat has been in a great measure absorbed, the fibres show a hazy hyaline appearance, and there is a not very marked progressive connective tissue development. The cross striation persists after the deposition of the fat, but in later stages may be somewhat impaired. The degenerative process apparently affects individual fibres in some selective way.

The anterior horn cells of the cord, and the cells of the spinal ganglia, show very widespread changes, of which the distinguishing characteristics are twofold, viz., chromatolysis in the centre of the cell, and dislocation of the nucleus to the periphery. Any apparent absence of the nucleus is

deceitful; extrusion of the nucleus does not appear to occur. This fact, in conjunction with the absence of alteration of staining property of the nucleus, would seem to show that in the majority of cells the changes are capable of recovery. I have not been able to satisfy myself that the chromolytic change ever begins at the place of origin of the axis cylinder process, or at any other point on the periphery; in many cells it certainly commences in the centre of the cell, about the nucleus, before the nucleus becomes displaced laterally.

It is to be noted that the peripheral motor and sensory neurones may be affected in any part, though in different degrees in their different parts. In addition to the degeneration of peripheral motor nerve-fibres, there are the extensive and well-marked changes in the motor cells of the cord and medulla, and there is degeneration of some of the motor root fibres, both within and without the cord. sensory side, there is not only a degeneration of peripheral sensory nerve-fibres, but there is extensive alteration of posterior root ganglion cells, and moderately numerous degenerated fibres are seen in the posterior roots, both outside and inside the cord. And in addition there is a very well marked degeneration of the central prolongations of these sensory neurones in the posterior columns of the cord, as is shown by the distribution of the posterior column degeneration. This distribution corresponds distinctly to that of the exogenous fibres. The evidence for this consists in the observation that there is conspicuous degeneration in. the root zones, especially in the cervical and lumbo-sacral enlargements where the fibres from the limbs enter the cord: that in the cervical region the degeneration is most marked in the posterior two-thirds of Goll's columns near the middle line, where the long fibres from the lumbo-sacral roots are situated; and that the cornu-commissural zones are free from degenerated fibres, as well as Flechsig's central oval area in the lumbar region. In this case, therefore, a peripheral sensory neurone may be affected in any part, or in every part. But those parts nearest the trophic cells are least often and least severely affected. The morbid process affects whole neurones, and this statement holds good, apart

altogether from the question whether the recognisable cell changes, as we see them, are or are not dependent, wholly or in part, upon the fibre lesion.

The affection of cortical neurones presents analogies to that of peripheral neurones. For many of the large pyramidal cells show a similar central chromatolysis and nuclear displacement, associated with degeneration of related axis cylinder processes in the pyramidal tracts and in the cortico-thalamic connections in the anterior limb of the internal capsule.

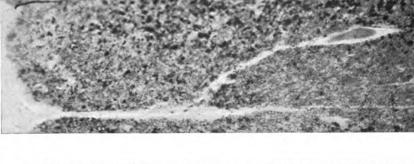
A review of the lesions as a whole tends to suggest that alcoholic paralysis is something more than a mere peripheral neuritis, and that it is, in general, a manifestation of an affection of whole neurones of various orders. That it is not a mere peripheral disease is shown by the co-existence of a more or less characteristic mental disorder, by the atrophy of tangential fibres, the cortical cell affection, and the degenerations in the pyramidal system, in the anterior limb of the capsule, in the cerebellum, and in the posterior columns of the cord.

It may be noted that in the present case the direct cerebellar tracts and the cells of Clarke's columns are normal, though frequently found to be altered in cases of chronic alcoholism. The widespread affection of cranial nerves and their related cells deserve a word of mention: in this connection, the vagus degeneration is of clinical importance, as it appeared to be in no small measure responsible for the fatal issue in this case.

The presence of abundance of choline in the blood in this case is of interest as an index of the extensive myelin degeneration in progress at the time of death. As we know, choline is one of the products of decomposition of myelin.

In conclusion, I have to express my thanks to Dr. Mott for kindly placing the resources of the Claybury Laboratory at my disposal for the investigation of this case; I also had the privilege of his co-operation at the autopsy. My friend Dr. J. S. Bolton has given me useful suggestions, more especially in connection with technical methods. The micro-photographs were taken by Mr. R. Welford, of Colney Hatch Asylum.

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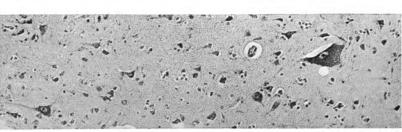
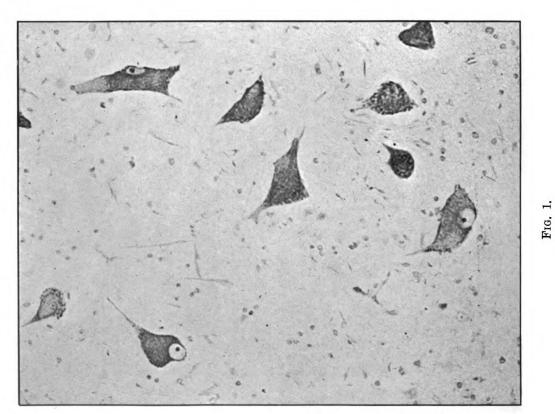


Fig. 2.

Fig. 3.



To face p. 857.

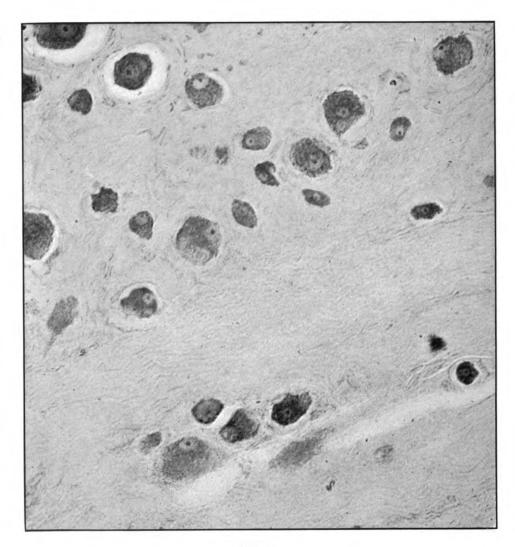


Fig. 4.

Systematic Examination of the Central and Peripheral Nervous System and Muscles in a Case of Acute Alcoholic Paralysis with Mental Symptoms.

To follow Plate I.

DESCRIPTION OF ILLUSTRATIONS.

PLATE I.

- Fig. 1.—Micro-photograph of a group of anterior horn cells from the lower lumbar region (Nissl's stain), showing various degrees of central chromatolysis and nuclear displacement. (The pale area in the narrower extremity of the elongated cell in the right-hand top corner of the picture is a mass of pigment.)
- Fig. 2.—Micro-photograph of portion of section of cortex of paracentral lobule (Nissl's stain), showing one of the Betz cells with typical central chromatolysis and nuclear excentricity.
- Fig. 3.—Microphotograph of small portion of transverse section of cord, at the level of the fifth lumbar segment (Marchi's stain). At the top of the picture is seen the posterior surface of the cord. To the left side is seen the posterior third of the postero-median septum, from which a subsidiary septum is seen diverging. Below and to the left of this latter is seen a portion of Flechsig's central oval area, composed of endogenous fibres (in this case free from degeneration). In the rest of the field—above and to the right—are seen a considerable number of degenerated fibres stained black by the osmic acid.

PLATE II.

Fig. 4.—Micro-photograph of a portion of a section of the first sacral posterior root ganglion (Nissl's stain), showing similar changes to those seen in fig. 1 (Plate I.).

NOTE UPON THE CHOLINE TEST FOR ACTIVE DEGENERATION OF THE NERVOUS SYSTEM.

BY F. W. MOTT, M.D., F.R.S.

THE work which Professor Halliburton and I have done on the chemistry of nerve degeneration has been published in extenso in the Croonian Lectures of 1900 and 1901, and in the Philosophical Transactions of the Royal Society, 1899 and 1901, but I wish here to describe the method which may be employed for giving a practical bearing to this work.

Now that we have shown experimentally that there is a proportional relationship between the presence of choline in the blood and the amount of nervous tissue undergoing active degeneration, it may be concluded that a relative large amount of choline in the blood of patients suffering with nervous disease may point to extensive and active organic destruction. This we have found both chemically and physiologically, and to those of my readers who wish to obtain full data thereon, I would refer them to the above publications.

It is, however, the extension of this test to clinical purposes, and the practical inferences which can be deduced therefrom, that induce me to publish the following facts, for I wish other workers to test the validity of the results; and if unable to afford the time, that they should send me samples of blood, with brief clinical notes of the cases after I have made the test, so that I may be perfectly unbiassed as to the result.

First, I will describe the modus operandi, and secondly, give a list of the cases upon which the test has been tried, and thirdly, point out some of the practical deductions.

The test can usually be obtained satisfactorily with 5 ccs. of blood, but if that is not obtainable even less will suffice. I have recommended arm venesection in some cases, especially where there have been successive fits, the opera-

¹ Published by Bale and Sons.

tion being beneficial to the patient, and, of course, a considerable quantity of blood can be obtained in this way. Should this method not be deemed advisable 5 to 10 ccs. can be drawn by means of a sterile hypodermic syringe from a vein in the arm, or even by ordinary puncture of the skin with a surgical needle, although the latter is not so satisfactory as drawing from the vein with a syringe.

In some cases the blood was taken shortly after death by ligaturing the femoral vein above and below, so as to include about three inches. The blood obtained by one of these methods is mixed with about six or eight times its volume of absolute alcohol. This is allowed to stand for some time, stirring occasionally, and then filtered; the alcoholic filtrate is evaporated to dryness at 40° C., and the residue taken up with absolute alcohol. After filtration the alcoholic solution is again evaporated to dryness and the residue again taken up with absolute alcohol. This is repeated twice more in order to ensure the absence of potassium salts. The final alcoholic solution is used for the test. One drop of a 10 per cent. solution of platinum chloride in alcohol is added, and the precipitate which forms after standing for a little while is allowed to settle, and then washed by decantation with absolute alcohol. It is then dissolved in 15 per cent. alcohol, but it does not all dissolve, so the platinum chloride must have precipitated substances other than choline; the solution is freed from the insoluble residue, which probably consists of other products of the lecithin group, by filtration, and then evaporated in a watch glass to dryness at 40° C. Microscopical examination of the watch glass with a low power shows yellow octahedral crystals of the double salt of platinum and choline. Using 10 ccs. of normal human blood the results are practically negative, although frequently a few small octahedra may be found on careful examination.

Cases of Organic Disease of the Nervous System in which the above Test was applied, and in every instance with Positive Results.

These cases may be divided into two groups: (1) those which have already proved fatal, and in which in some cases

the blood was obtained shortly after death; (2) those in which the blood was taken from the patients during life, and which have not yet proved fatal. The tissues of the peripheral or central nervous system of the first-named group were examined by the Marchi method, and, according to the nature of the disease, extensive recent degeneration was found in the peripheral nerves and central nervous system. The blood was examined in fourteen cases of organic disease of the nervous system, and in all these choline was found present in abnormal amounts, and in many instances in great abundance and proportional to the extent and activity of the destruction of nervous tissue.

GROUP I .- Fatal Cases.

GROUP II.

Three cases of beri-beri.
One case of acute alcoholic neuritis.
One case of combined sclerosis.
One case of Pott's disease.
Two cases of tabo-paralysis ending fatally in convulsive seizures.

Three cases of disseminated sclerosis.

Two cases of amytrophic lateral sclerosis.

One case of focal myelitis.

Professor Halliburton and I have already published the chemical and physiological results obtained from the cases of beri-beri, combined sclerosis and alcoholic neuritis. The remaining cases I have only examined by the chemical test described above.

The tissues were examined in all the fatal cases with the exception of one case of beri-beri, and all gave the Marchi reaction. In another part of this volume I have described the microscopical results obtained in the two cases of tabo-paralysis in which death was preceded by frequent convulsive seizures (pp. 170, 209, Cases 44 and 54), and Dr. Cole has described the degeneration in the case of acute alcoholic polyneuritis. In connection with beri-beri it is interesting to learn that Dr. Durham, who has been working at this subject in the Straits Settlements, where it exists in an epidemic form, has found great abundance of choline and other bodies of the lecithin group in the blood of patients dying with this disease. The blood, taken during life from several cases of general paralysis suffering with continuous

epileptiform seizures, we have shown yielded both physiological and chemical tests, indicating the existence of a considerable quantity of choline. In other cases of general paralysis, where there have been no fits, in tabes and cases of chronic insanity, where there was but little evidence of recent active degeneration, only comparatively small quantities of choline were present.

This shows what one would logically infer from our experimental observations upon the chemistry of nerve degeneration.

The test is of no use to decide whether a case is organic or functional, unless the organic disease is active at the time the blood is drawn; it would therefore be especially applicable after the onset of new symptoms indicative of irritative or destructive processes.

We know that after an experimental lesion the Marchi reaction of degeneration becomes very evident eight or ten days later, and about this period and for a week or two later considerable quantities of choline may be found in the blood. To apply this knowledge—given a case which suddenly develops paralysis or other symptoms of organic disease—the blood taken from the patient a week later will give the choline reaction, and will continue to do so all the while there is active breaking up of the myelin. Whether this is a continuous process, or occurring in sudden outbursts. depends entirely upon the nature of the pathological process. If it is a parenchymatous process the myelin decomposition is more likely to be continuous, but not excessive; therefore the choline would not be in abundance, but proportional to the extent and rapidity of the process. Hæmorrhage or vascular obstruction would lead to sudden destructive changes, and the choline would be abundant for a week or two, and then diminish rapidly.

The quantitative test, as measured by the abundance of the octahedral crystals obtained from a small definite quan-

^{1 &}quot;The Physiological Action of Choline and Neurine." Mott and Halliburton, Phil. Trans. Royal Soc., 1899.

² "The Chemistry of Nerve Degeneration." Mott and Halliburton, *Phil. Trans. Royal Soc.*, 1901.

tity of blood, affords information relating to (1) active decomposition of myelin; (2) continuance of the process.

It is important to note that other intermediate bodies between lecithin and choline may exist in the blood and possess a toxic action.

In conclusion, I wish to thank my friend, Dr. Holt of Burnley, for kindly sending me four samples of blood from nervous cases for examination.

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